Actividad Colaborativa 1

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RESUMEN

El trabajo se realizó con base a lo estudiado en el curso de profundización, consiste en dos laboratorio los cuales deben ser ejecutados bajo el software de simulación Packet-Tracer, propietario de cisco network, lo anterior con base a finalidad de cumplir satisfactoriamente las competencias y conocimientos suministrados, así mismo se ha logrado culminar el proceso de certificación.

En el presente trabajo se expondrá la solución de los laboratorios los cuales son desarrollados en packet tracer o en GN3, nos darán las configuraciones básicas de los equipos, los cuales debemos, probar virtualmente y realizar las los enlaces de acuerdo a la guía.

INTRODUCCIÓN

hoy en día la tecnología se ha vuelto un icono ya que todos tenemos la necesidad de saberla utilizar , En la Universidad Nacional Abierta Y a Distancia 'UNAD' se ha implementado una opción de grado para la carrera de Ingeniería de sistemas la cual trata de un curso de profundización en redes, el cual es dictado por la UNAD y CISCO con la cual podemos aprender a realizar conectividades en el hogar, servicios de aplicación de red, seguridad de redes, redes de área de almacenamiento, sistemas de video. Cisco Systems, Inc. es el líder mundial en redes para Internet. Hoy en día, las redes son una parte esencial en los negocios, la educación, el gobierno y las comunicaciones en el hogar, y las soluciones de conectividad basadas en el Protocolo de Internet (IP) de Cisco son las bases de estas redes.

OBJETIVOS

Objetivo general:

- Configurar y administrar dispositivos de networking mediante el uso de protocolos de enrutamiento avanzado.

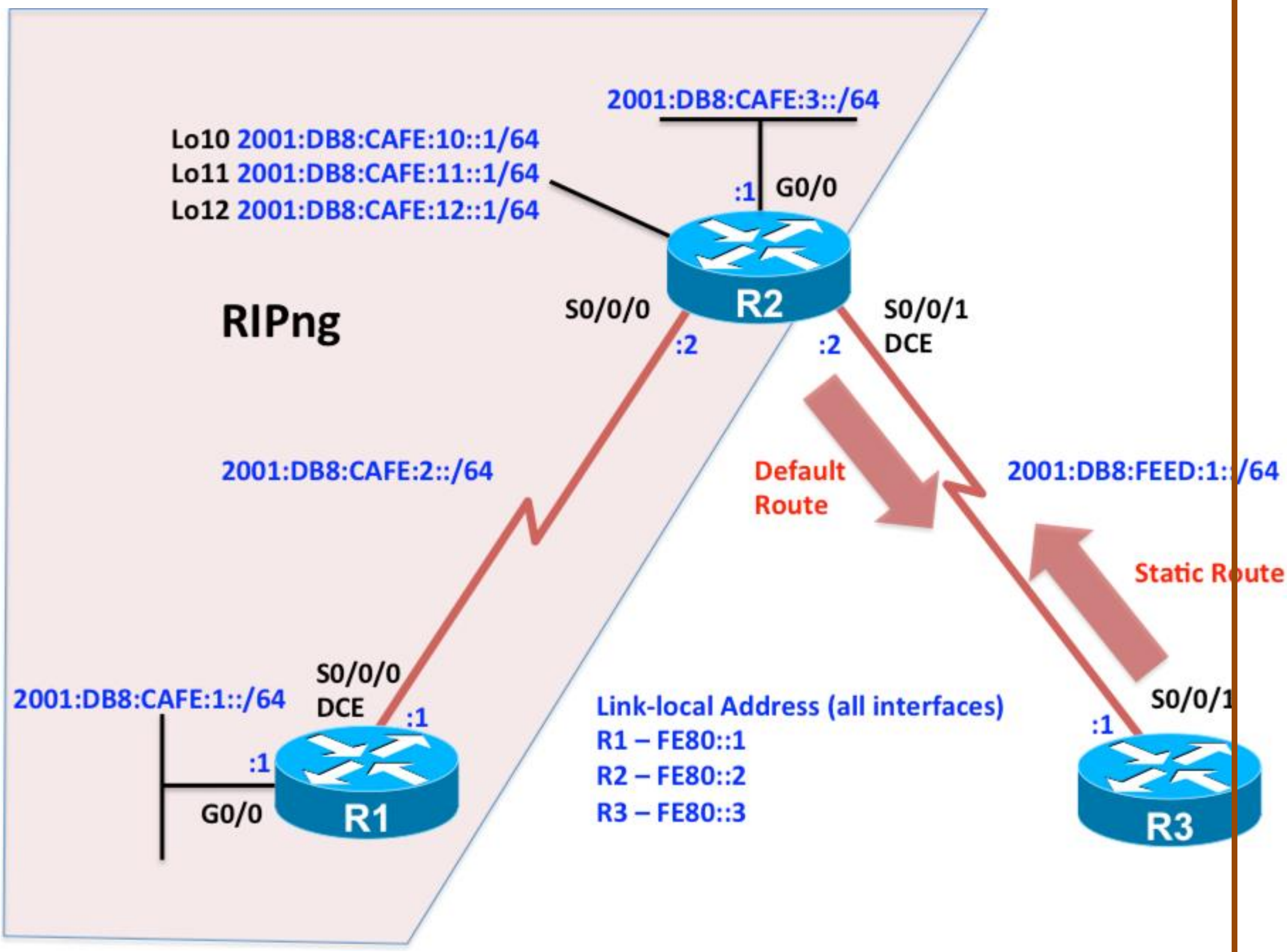
Objetivos específicos:

- configurar dispositivos
- administrar dispositivos
- desarrollar protocolos
- aplicar enrutamiento avanzado

DESARROLLO DE LA ACTIVIDAD

Chapter 1 Lab 1-1, Basic RIPng and Default Gateway Configuration

Topology



Objectives

- Configure IPv6 addressing.
- Configure and verify RIPng on R1 and R2.
- Configure IPv6 static routes between R2 and R3.
- Propagate a default route using RIPng.
- Examine the RIP process and RIP database.

Background

In this lab you will be configuring a new network to connect a company's Engineering, Marketing, and Accounting departments using IPv6 and RIPng on two routers. You will also be configuring IPv6 static routing between the company's gateway router (R2) and an ISP (R3). The gateway router will propagate the IPv6 default route via RIPng. Your task is to configure RIPng to enable full connectivity between all routers.

Note: This lab uses Cisco 1941 routers with Cisco IOS Release 15.4 with IP Base. The switches are Cisco WS-C2960-24TT-L with Fast Ethernet interfaces, therefore the router will use routing metrics associated with a 100 Mb/s interface. Depending on the router or switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 3 routers (Cisco IOS Release 15.2 or comparable)
- 2 switches (LAN interfaces)
- Serial and Ethernet cables

Step 0: Suggested starting configurations.

a. Apply the following configuration to each router along with the appropriate **hostname**. The **exec-timeout 0 0** command should only be used in a lab environment.

```
Router(config)# no ip domain-lookup
Router(config)# line con 0
Router(config-line)# logging synchronous
Router(config-line)# exec-timeout 0 0
```

Step 1: Configure addressing and loopbacks.

b. Using the addressing scheme in the diagram, apply IPv6 addresses to the Fast Ethernet interfaces and serial interfaces R1, R2, and R3. Then create Loopback1 on R1, Loopback2 on R2, and Loopback3 on R3 and address them according to the diagram.

```
R1(config)# interface GigabitEthernet 0/0
R1(config-if)# description Engineering Department
R1(config-if)# ipv6 address 2001:db8:cafe:1::1/64
R1(config-if)# ipv6 address fe80::1 link-local
R1(config-if)# no shutdown
R1(config-if)# exit
R1(config)# interface serial 0/0/0
R1(config-if)# description Serial link to R2
R1(config-if)# ipv6 address 2001:db8:cafe:2::1/64
R1(config-if)# ipv6 address fe80::1 link-local
R1(config-if)# clock rate 64000
R1(config-if)# no shutdown

R2(config)# interface GigabitEthernet 0/0
R2(config-if)# description Accounting Department
R2(config-if)# ipv6 address 2001:db8:cafe:3::1/64
R2(config-if)# ipv6 address fe80::2 link-local
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Loopback 10
R2(config-if)# description Marketing Department
R2(config-if)# ipv6 address 2001:db8:cafe:10::1/64
```

```
R2(config-if)# ipv6 address fe80::2 link-local
R2(config-if)# exit
R2(config)# interface Loopback 11
R2(config-if)# description Marketing Department
R2(config-if)# ipv6 address 2001:db8:cafe:11::1/64
R2(config-if)# ipv6 address fe80::2 link-local
R2(config-if)# exit
R2(config)# interface Loopback 12
R2(config-if)# description Marketing Department
R2(config-if)# ipv6 address 2001:db8:cafe:12::1/64
R2(config-if)# ipv6 address fe80::2 link-local
R2(config-if)# exit
R2(config)# interface Serial 0/3/0
R2(config-if)# description Serial link to R1
R2(config-if)# ipv6 address 2001:db8:cafe:2::2/64
R2(config-if)# ipv6 address fe80::2 link-local
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Serial 0/3/1
R2(config-if)# description Serial link to R3
R2(config-if)# ipv6 address 2001:db8:feed:1::2/64
R2(config-if)# ipv6 address fe80::2 link-local
R2(config-if)# clock rate 64000
R2(config-if)# no shutdown
R2(config-if)# exit

R3(config)# interface Serial 0/0/1
R3(config-if)# description Serial link to R2
R3(config-if)# ipv6 address 2001:db8:feed:1::1/64
R3(config-if)# ipv6 address fe80::3 link-local
R3(config-if)# no shutdown
```

Leave the switch in its default (blank) configuration. By default, all switch ports are in VLAN1 and are not administratively down.

Note: If the switch has been previously configured, erase the startup config, delete the vlan.dat file from flash memory, and reload the switch.

c. Verify that the line protocol of each interface is up and that you can successfully ping across each link. You should see output similar to the following on each router.

```
R2# show ipv6 interface brief
GigabitEthernet0/0     [up/up]
    FE80::2
    2001:DB8:CAFE:3::1
Serial0/0/0            [up/up]
    FE80::2
    2001:DB8:CAFE:2::2
Serial0/0/1            [up/up]
    FE80::2
    2001:DB8:FEED:1::2
Loopback10             [up/up]
    FE80::2
    2001:DB8:CAFE:10::1
Loopback11             [up/up]
    FE80::2
    2001:DB8:CAFE:11::1
Loopback12             [up/up]
    FE80::2
    2001:DB8:CAFE:12::1
R2#
```

Step 2: Configure RIPng on R1 and R2.

a. After you have implemented your addressing scheme, enable RIPng on R1 using the following commands in global configuration mode.

```
R1(config)# ipv6 router rip ROUTING-RIPng
% IPv6 routing not enabled
R1(config)# ipv6 unicast-routing
R1(config)# ipv6 router rip ROUTING-RIPng
R1(config-rtr)# exit
R1(config)# interface gigabitethernet 0/0
R1(config-if)# ipv6 rip ROUTING-RIPng enable
R1(config-if)# exit
R1(config)# interface serial 0/0/0
R1(config-if)# ipv6 rip ROUTING-RIPng enable
```

Notice that IPv6 routing must be enabled prior to configuring RIPng using the **ipv6 unicast-routing** command. The network statement has been eliminated in RIPng. RIPng routing is enabled at the interface level instead, and is identified by a locally significant process name as multiple processes can be created with RIPng.

b. Configure RIPng on R2 using the following commands.

```
R2(config)# ipv6 unicast-routing
R2(config)# interface serial 0/0/0
R2(config-if)# ipv6 rip ROUTING-RIPng enable
R2(config-if)# exit
R2(config)# interface gigabitEthernet 0/0
R2(config-if)# ipv6 rip ROUTING-RIPng enable
R2(config-if)# exit
R2(config)# interface loopback 10
R2(config-if)# ipv6 rip ROUTING-RIPng enable
R2(config-if)# exit
R2(config)# interface loopback 11
R2(config-if)# ipv6 rip ROUTING-RIPng enable
R2(config-if)# exit
R2(config)# interface loopback 12
R2(config-if)# ipv6 rip ROUTING-RIPng enable
```

As shown on R2, the RIPng process can be configured on the interface without first configuring the RIPng process in global configuration mode. The RIPng process will automatically be created if it doesn't already exist.

Step 3: Verify the RIPng configuration.

c. Verify that the RIPng process is running on R2.

```
R2# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "application"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "rip ROUTING-RIPng"
  Interfaces:
    Loopback12
    Loopback11
    Loopback10
    GigabitEthernet0/0
    Serial0/0/0
  Redistribution:
    None
R2#
```

Which interfaces are involved in the RIPng routing process on router R2?

Loopback 10, 11, 12, Serial 0/3/0 y GigabitEthernet 0/0 participan cada uno en el proceso de enrutamiento RIPng en R2

Which active interface(s) are NOT involved in the RIPng routing process on router R2?

El Serial 0/3/1 no participa en el proceso de enrutamiento RIPng en R2

d. Use the **show ipv6 route** command to view R1's IPv6 routing table.

```
R1#show ipv6 route
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP
external
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr -
Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF
ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application
C   2001:DB8:CAFE:1::/64 [0/0]
     via GigabitEthernet0/0, directly connected
L   2001:DB8:CAFE:1::1/128 [0/0]
     via GigabitEthernet0/0, receive
C   2001:DB8:CAFE:2::/64 [0/0]
     via Serial0/0/0, directly connected
L   2001:DB8:CAFE:2::1/128 [0/0]
     via Serial0/0/0, receive
R   2001:DB8:CAFE:3::/64 [120/2]
     via FE80::2, Serial0/0/0
R   2001:DB8:CAFE:10::/64 [120/2]
     via FE80::2, Serial0/0/0
R   2001:DB8:CAFE:11::/64 [120/2]
     via FE80::2, Serial0/0/0
R   2001:DB8:CAFE:12::/64 [120/2]
     via FE80::2, Serial0/0/0
L   FF00::/8 [0/0]
     via Null0, receive
R1#
```

What is the next-hop address and the type of IPv6 address for the RIPng routes on R1?

FE80 :: 2, que es la dirección IPv6 enlace local de la interfaz serial 0/3/0 de R2

e. Ping the following remote addresses 2001:db8:cafe:3::1, 2001:db8:cafe:10::1, and 2001:db8:feed:1::1.

Which pings were successful and which were not? If there were any pings that were unsuccessful, explain the reason why.

Pings a 2001: db8: cafe: 3 :: 1 y 2001: db8: cafe: 10 :: 1 fueron exitosos. Pings a 2001: db8: feed: 1 :: 1 no tuvieron éxito. Los pings a 2001: db8: feed: 1 :: 1 no tuvieron éxito porque R1 no tiene una ruta a ese prefijo y no tiene una ruta predeterminada

Step 4: Configure IPv6 static routing between R2 and R3.

f. Configure an IPv6 static route on R3 forwarding all packets for the 2001:DB8:CAFE::/48 prefix to R2.

```
R3(config)# ipv6 unicast-routing
R3(config)# ipv6 route 2001:db8:cafe::/48 2001:db8:feed:1::2
```

Note: The **ipv6 unicast-routing** command is required for a router to forward IPv6 packets, however IPv6 static routes can be configured without this command and forwarding IPv6 packets will be successful. However, it is suggested to use the **ipv6 unicast-routing** command.

g. Configure an IPv6 default static route on R2, forwarding packets to R3. Propagate the default route to other RIPng routers in addition to other routes in R2's routing table.

```
R2(config)# ipv6 route ::/0 2001:db8:feed:1::1
```

Step 5: Propagate the default route along with other routes via RIPng and verify.

h. Propagate the default route to other RIPng routers in addition to other routes in R2's routing table.

```
R2(config)# interface serial 0/0/0
R2(config-if)# ipv6 rip ROUTING-RIPng default-information originate
```

The **originate** keyword propagates the default route in addition to other routes in R2's routing table.

i. Display the RIPng routes in R1's IPv6 routing table. Verify that R1 is receiving both an IPv6 default route and other routes from R2 via RIPng.

```
R1# show ipv6 route rip
IPv6 Routing Table - default - 10 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP
external
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr -
Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF
ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application
R   ::/0 [120/2]
     via FE80::2, Serial0/0/0
R   2001:DB8:CAFE:3::/64 [120/2]
     via FE80::2, Serial0/0/0
R   2001:DB8:CAFE:10::/64 [120/2]
     via FE80::2, Serial0/0/0
R   2001:DB8:CAFE:11::/64 [120/2]
     via FE80::2, Serial0/0/0
R   2001:DB8:CAFE:12::/64 [120/2]
     via FE80::2, Serial0/0/0
R1#
```

What is the RIPng hop count for the default and other routes? Explain how the hop count is determined.

La cantidad de salto para todas las rutas RIPng es 2. Un enrutador RIPng se incluye en el conteo de saltos. Por ejemplo, 2001: DB8: CAFE: 3 :: / 64 es 2 saltos lejos, R1 más R2

j. To check whether you have full connectivity, from R1 ping the interfaces on R2 and R3. If you have successfully pinged all the remote interfaces, congratulations! You have configured RIPng including a default route.

Step 6: Propagate only the default route via RIPng and verify.

k. Remove the previous command that propagates the default route using the originate keyword and replace it with the same command using the only keyword.

```
R2(config)# interface serial 0/0/0
R2(config-if)# no ipv6 rip ROUTING-RIPng default-information
originate
R2(config-if)# ipv6 rip ROUTING-RIPng default-information only
```

l. Display the RIPng routes in R1's IPv6 routing table. Verify that R1 is only receiving an IPv6 default route from R2 via RIPng. You will need to wait for the routes to expire on R1 or issue the **clear ipv6 rip ROUTING-RIPng** command to clear the RIPng databases on R1 and R2.

```
R1# clear ipv6 rip ROUTING-RIPng
R1# show ipv6 route rip
IPv6 Routing Table - default - 6 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP, EX - EIGRP
external
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr -
Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF
ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, a - Application
R   ::/0 [120/2]
     via FE80::2, Serial0/0/0
R1#
```

Step 7: Examine the RIPng process on R2.

m. On R2, use the **show ipv6 rip** command to display the RIPng process.

```
R2# show ipv6 rip
RIP process "ROUTING-RIPng", port 521, multicast-group FF02::9, pid
240
     Administrative distance is 120. Maximum paths is 16
     Updates every 30 seconds, expire after 180
     Holddown lasts 0 seconds, garbage collect after 120
     Split horizon is on; poison reverse is off
     Default routes are generated
     Periodic updates 338, trigger updates 5
     Full Advertisement 0, Delayed Events 0
  Interfaces:
    Loopback12
    Loopback11
    Loopback10
    GigabitEthernet0/0
    Serial0/0/0
  Redistribution:
    None
```

```
R2#
```

How many RIPng processes are running on R2 and what are the process names?

Sólo hay un proceso RIPng ejecutándose en R2 con el nombre de proceso ROUTING-RIPng

What port number does RIPng use?

Puerto 521

What destination address and type of address does RIPng use to send updates?

RIPng usa la IPv6 multicast address FF02::9

Step 8: Examine the RIPng database and next-hops on R2.

n. On R2, examine the RIPng database.

```
R2# show ipv6 rip database
RIP process "ROUTING-RIPng", local RIB
 2001:DB8:CAFE:1::/64, metric 2, installed
     Serial0/0/0/FE80::1, expires in 171 secs
 2001:DB8:CAFE:2::/64, metric 2
     Serial0/0/0/FE80::1, expires in 171 secs
R2#
```

How many entries are in the RIP database?

Dos, 2001:DB8:CAFE:1::/64 y 2001:DB8:CAFE:2::/64

Which entry is installed in the IPv6 routing table and why is the other route not included?

Sólo la entrada 2001: DB8: CAFE: 1 :: / 64 se instala en la tabla de enrutamiento IPv6. El 2001: DB8: CAFE: 2 :: / 64 no está instalado como una ruta RIPng porque se instala como una red conectada directamente que tiene una menor distancia administrativa

What is the next-hop IPv6 address and exit-interface of both RIP database entries?

Las entradas tienen la siguiente dirección de salto FE80 :: 2 y la salida de interfaz serie 0/3/0

What happens when “expires in n seconds” reaches 0? What keeps this value from expiring?

Cuando el temporizador cuenta de atrás y llega a 0, la ruta se elimina de la tabla de enrutamiento y se marca como expirada. RIPng envía actualizaciones periódicas cada 30 segundos que actualiza el temporizador de cuenta regresiva.

o. On R2, examine the number of next-hops for the RIPng process.

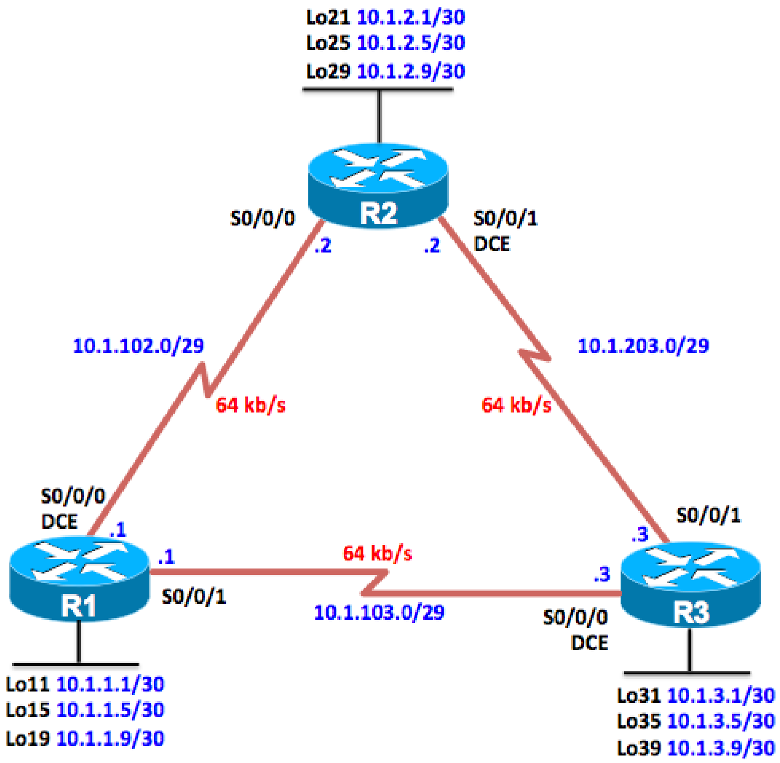
```
R2# show ipv6 rip ROUTING-RIPng next-hops
 RIP process "ROUTING-RIPng", Next Hops
  FE80::1/Serial0/0/0 [2 paths]
R2#
```

Why are there two paths from the next-hop FE80::1/Serial0/0/0 but only one route in the IPv6 routing table using the next-hop FE80::1?

Una ruta es para el prefijo 2001: DB8: CAFE: 1 :: / 64 que está en la tabla de enrutamiento IPv6. El segundo camino es para el prefijo 2001: DB8: CAFE: 2 :: / 64 que no está usando el siguiente salto FE80 :: 1 porque su red conectada directamente (distancia administrativa de 0) es un camino mejor.

Chapter 2 Lab 2-1, EIGRP Load Balancing

Topology



Objectives

- Review a basic EIGRP configuration.
- Explore the EIGRP topology table.

- Identify successors, feasible successors, and feasible distances.
- Use **show** and **debug** commands for the EIGRP topology table.
- Configure and verify equal-cost load balancing with EIGRP.
- Configure and verify unequal-cost load balancing with EIGRP.

Background

As a senior network engineer, you are considering deploying EIGRP in your corporation and want to evaluate its ability to converge quickly in a changing environment. You are also interested in equal-cost and unequal-cost load balancing because your network contains redundant links. These links are not often used by other link-state routing protocols because of high metrics. Because you are interested in testing the EIGRP claims that you have read about, you decide to implement and test on a set of three lab routers before deploying EIGRP throughout your corporate network.

Note: This lab uses Cisco 1941 routers with Cisco IOS Release 15.4 with IP Base. Depending on the Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 3 routers (Cisco IOS Release 15.2 or comparable)
- Serial and Ethernet cables

Step 0: Suggested starting configurations.

p. Apply the following configuration to each router along with the appropriate **hostname**. The **exec-timeout 0 0** command should only be used in a lab environment.

```
Router(config)# no ip domain-lookup
Router(config)# line con 0
Router(config-line)# logging synchronous
Router(config-line)# exec-timeout 0 0
```

Step 1: Configure the addressing and serial links.

q. Create three loopback interfaces on each router and address them as 10.1.*X*.1/30, 10.1.*X*.5/30, and 10.1.*X*.9/30, where *X* is the number of the router. Use the following table or the initial configurations located at the end of the lab.

Router	Interface	IP Address/Mask
R1	Loopback11	10.1.1.1/30
R1	Loopback15	10.1.1.5/30
R1	Loopback19	10.1.1.9/30
R2	Loopback21	10.1.2.1/30
R2	Loopback25	10.1.2.5/30
R2	Loopback29	10.1.2.9/30
R3	Loopback31	10.1.3.1/30
R3	Loopback35	10.1.3.5/30
R3	Loopback39	10.1.3.9/30

```
R1(config)# interface Loopback 11
```

```
R1(config-if)# ip address 10.1.1.1 255.255.255.252
R1(config-if)# exit
R1(config)# interface Loopback 15
R1(config-if)# ip address 10.1.1.5 255.255.255.252
R1(config-if)# exit
R1(config)# interface Loopback 19
R1(config-if)# ip address 10.1.1.9 255.255.255.252
R1(config-if)# exit

R2(config)# interface Loopback 21
R2(config-if)# ip address 10.1.2.1 255.255.255.252
R2(config-if)# exit
R2(config)# interface Loopback 25
R2(config-if)# ip address 10.1.2.5 255.255.255.252
R2(config-if)# exit
R2(config)# interface Loopback 29
R2(config-if)# ip address 10.1.2.9 255.255.255.252
R2(config-if)# exit

R3(config)# interface Loopback 31
R3(config-if)# ip address 10.1.3.1 255.255.255.252
R3(config-if)# exit
R3(config)# interface Loopback 35
R3(config-if)# ip address 10.1.3.5 255.255.255.252
R3(config-if)# exit
R3(config)# interface Loopback 39
R3(config-if)# ip address 10.1.3.9 255.255.255.252
R3(config-if)# exit
```

r. Specify the addresses of the serial interfaces as shown in the topology diagram. Set the clock rate to 64 kb/s, and manually configure the interface bandwidth to 64 kb/s.

Note: If you have WIC-2A/S serial interfaces, the maximum clock rate is 128 kb/s. If you have WIC-2T serial interfaces, the maximum clock rate is much higher (2.048 Mb/s or higher depending on the hardware), which is more representative of a modern network WAN link. However, this lab uses 64 kb/s and 128 kb/s settings.

```
R1(config)# interface Serial 0/0/0
R1(config-if)# description R1-->R2
R1(config-if)# clock rate 64000
R1(config-if)# bandwidth 64
R1(config-if)# ip address 10.1.102.1 255.255.255.248
R1(config-if)# no shutdown
R1(config-if)# exit
R1(config)# interface Serial 0/0/1
R1(config-if)# description R1-->R3
R1(config-if)# bandwidth 64
R1(config-if)# ip address 10.1.103.1 255.255.255.248
R1(config-if)# no shutdown
R1(config-if)# exit

R2(config)# interface Serial 0/0/0
R2(config-if)# description R2-->R1
R2(config-if)# bandwidth 64
R2(config-if)# ip address 10.1.102.2 255.255.255.248
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Serial 0/0/1
R2(config-if)# description R2-->R3
R2(config-if)# clock rate 64000
R2(config-if)# bandwidth 64
R2(config-if)# ip address 10.1.203.2 255.255.255.248
```

```
R2(config-if)# no shutdown
R2(config-if)# exit

R3(config)# interface Serial 0/0/0
R3(config-if)# description R3-->R1
R3(config-if)# clock rate 64000
R3(config-if)# bandwidth 64
R3(config-if)# ip address 10.1.103.3 255.255.255.248
R3(config-if)# no shutdown
R3(config-if)# exit
R3(config)# interface Serial 0/0/1
R3(config-if)# description R3-->R2
R3(config-if)# bandwidth 64
R3(config-if)# ip address 10.1.203.3 255.255.255.248
R3(config-if)# no shutdown
R3(config-if)# exit
```

s. Verify connectivity by pinging across each of the local networks connected to each router.

t. Issue the **show interfaces description** command on each router. This command displays a brief listing of the interfaces, their status, and a description (if a description is configured). Router R1 is shown as an example.

```
R1# show interfaces description
Interface                      Status         Protocol Description
Em0/0                          admin down     down
Gi0/0                          admin down     down
Gi0/1                          admin down     down
Se0/0/0                        up             up       R1-->R2
Se0/0/1                        up             up       R1-->R3
Lo11                           up             up
Lo15                           up             up
Lo19                           up             up
R1#
```

u. Issue the **show protocols** command on each router. This command displays a brief listing of the interfaces, their status, and the IP address and subnet mask configured (in prefix format /xx) for each interface. Router R1 is shown as an example.

```
R1# show protocols
Global values:
  Internet Protocol routing is enabled
Embedded-Service-Engine0/0 is administratively down, line protocol is
down
GigabitEthernet0/0 is administratively down, line protocol is down
GigabitEthernet0/1 is administratively down, line protocol is down
Serial0/0/0 is up, line protocol is up
  Internet address is 10.1.102.1/29
Serial0/0/1 is up, line protocol is up
  Internet address is 10.1.103.1/29
Loopback11 is up, line protocol is up
  Internet address is 10.1.1.1/30
Loopback15 is up, line protocol is up
  Internet address is 10.1.1.5/30
Loopback19 is up, line protocol is up
  Internet address is 10.1.1.9/30
R1#
```

Step 2: Configure EIGRP.

v. Enable EIGRP AS 100 for all interfaces on R1 and R2 using the commands. Do not enable EIGRP yet on R3. For your reference, these are the commands which can be used:

```
R1(config)# router eigrp 100
R1(config-router)# network 10.0.0.0

R2(config)# router eigrp 100
R2(config-router)# network 10.0.0.0
```

w. Use the **debug ip routing** and the **debug ip eigrp 100** commands to watch EIGRP install the routes in the routing table when your routers become adjacent. (Note: The type of output you receive may vary depending upon the IOS.) You get output similar to the following.

```
R3# debug ip routing
IP routing debugging is on
R3# debug ip eigrp 100
R3# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)# router eigrp 100
*Jun 22 11:06:09.315: RT: add router 2048, all protocols have local
database
R3(config-router)# network 10.0.0.0
*Jun 22 11:06:18.591: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.1.103.1 (Serial0/0/0) is up: new adjacency
*Jun 22 11:06:18.591: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.1.203.2 (Serial0/0/1) is up: new adjacency
*Jun 22 11:06:19.055: RT: updating eigrp 10.1.102.0/29 (0x0)  :
    via 10.1.103.1 Se0/0/0  0 1048578

*Jun 22 11:06:19.055: RT: add 10.1.102.0/29 via 10.1.103.1, eigrp
metric [90/41024000]
*Jun 22 11:06:19.055: RT: updating eigrp 10.1.1.0/30 (0x0)  :
    via 10.1.103.1 Se0/0/0
R3(config-router)#end  0 1048578

*Jun 22 11:06:19.055: RT: add 10.1.1.0/30 via 10.1.103.1, eigrp
metric [90/40640000]
*Jun 22 11:06:19.055: RT: updating eigrp 10.1.1.4/30 (0x0)  :
    via 10.1.103.1 Se0/0/0  0 1048578

*Jun 22 11:06:19.055: RT: add 10.1.1.4/30 via 10.1.103.1, eigrp
metric [90/40640000]
*Jun 22 11:06:19.055: RT: updating eigrp 10.1.1.8/30 (0x0)  :
    via 10.1.103.1 Se0/0/0  0 1048578

*Jun 22 11:06:19.055: RT: add 10.1.1.8/30 via 10.1.103.1, eigrp
metric [90/40640000]
*Jun 22 11:06:19.059: RT: updating eigrp 10.1.2.0/30 (0x0)  :
    via 10.1.103.1 Se0/0/0  0 1048578

*Jun 22 11:06:19.059: RT: add 10.1.2.0/30 via 10.1.103.1, eigrp
metric [90/41152000]
*Jun 22 11:06:19.059: RT: updating eigrp 10.1.2.4/30 (0x0)  :
    via 10.1.103.1 Se0/0/0  0 1048578

<output omitted>
R3#
R3(config-router)# end
R3#
R3#undebug all
```

```
All possible debugging has been turned off
R3#
```

Essentially, the EIGRP DUAL state machine has just computed the topology table for these routes and installed them in the routing table.

x. Check to see that these routes exist in the routing table with the **show ip route** command.

```
R3# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 17 subnets, 3 masks
D        10.1.1.0/30 [90/40640000] via 10.1.103.1, 00:10:54,
Serial0/0/0
D        10.1.1.4/30 [90/40640000] via 10.1.103.1, 00:10:54,
Serial0/0/0
D        10.1.1.8/30 [90/40640000] via 10.1.103.1, 00:10:54,
Serial0/0/0
D        10.1.2.0/30 [90/40640000] via 10.1.203.2, 00:10:54,
Serial0/0/1
D        10.1.2.4/30 [90/40640000] via 10.1.203.2, 00:10:54,
Serial0/0/1
D        10.1.2.8/30 [90/40640000] via 10.1.203.2, 00:10:54,
Serial0/0/1
C        10.1.3.0/30 is directly connected, Loopback31
L        10.1.3.1/32 is directly connected, Loopback31
C        10.1.3.4/30 is directly connected, Loopback35
L        10.1.3.5/32 is directly connected, Loopback35
C        10.1.3.8/30 is directly connected, Loopback39
L        10.1.3.9/32 is directly connected, Loopback39
D        10.1.102.0/29 [90/41024000] via 10.1.203.2, 00:10:54,
Serial0/0/1
                       [90/41024000] via 10.1.103.1, 00:10:54,
Serial0/0/0
C        10.1.103.0/29 is directly connected, Serial0/0/0
L        10.1.103.3/32 is directly connected, Serial0/0/0
C        10.1.203.0/29 is directly connected, Serial0/0/1
L        10.1.203.3/32 is directly connected, Serial0/0/1
R3#
```

y. After you have full adjacency between the routers, ping all the remote loopbacks to ensure full connectivity.

   You should receive ICMP echo replies for each address pinged.

z. Verify the EIGRP neighbor relationships with the **show ip eigrp neighbors** command.

```
R1# show ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT
RTO  Q  Seq
                                                   (sec)         (ms)
Cnt Num
1   10.1.103.3              Se0/0/1                  13 00:14:20   49
2340  0  6
0   10.1.102.2              Se0/0/0                  10 00:29:14   37
2340  0  36
R1#

R2# show ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT
RTO  Q  Seq
                                                   (sec)         (ms)
Cnt Num
1   10.1.203.3              Se0/0/1                  13 00:14:28   71
2340  0  7
0   10.1.102.1              Se0/0/0                  13 00:29:21   35
2340  0  36
R2#

R3# show ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT
RTO  Q  Seq
                                                   (sec)         (ms)
Cnt Num
1   10.1.203.2              Se0/0/1                  13 00:14:07 1305
5000  0  37
0   10.1.103.1              Se0/0/0                  14 00:14:07   42
2340  0  37
R3#
```

Step 3: Examine the EIGRP topology table.

aa. EIGRP builds a topology table containing all successor routes. The course content covered the vocabulary for EIGRP routes in the topology table. What is the feasible distance of route 10.1.1.0/30 in the R3 topology table in the following output?

La distancia factible (FD) para la ruta 10.1.1.0/30 es 40640000_______________________

```
R3# show ip eigrp topology
EIGRP-IPv4 Topology Table for AS(100)/ID(10.1.3.9)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.1.102.0/29, 2 successors, FD is 41024000
        via 10.1.103.1 (41024000/40512000), Serial0/0/0
        via 10.1.203.2 (41024000/40512000), Serial0/0/1
P 10.1.1.8/30, 1 successors, FD is 40640000
        via 10.1.103.1 (40640000/128256), Serial0/0/0
P 10.1.3.0/30, 1 successors, FD is 128256
        via Connected, Loopback31
P 10.1.3.4/30, 1 successors, FD is 128256
        via Connected, Loopback35
P 10.1.3.8/30, 1 successors, FD is 128256
```

```
        via Connected, Loopback39
P 10.1.2.8/30, 1 successors, FD is 40640000
        via 10.1.203.2 (40640000/128256), Serial0/0/1
P 10.1.2.0/30, 1 successors, FD is 40640000
        via 10.1.203.2 (40640000/128256), Serial0/0/1
P 10.1.103.0/29, 1 successors, FD is 40512000
        via Connected, Serial0/0/0
P 10.1.203.0/29, 1 successors, FD is 40512000
        via Connected, Serial0/0/1
P 10.1.1.4/30, 1 successors, FD is 40640000
        via 10.1.103.1 (40640000/128256), Serial0/0/0
P 10.1.2.4/30, 1 successors, FD is 40640000
        via 10.1.203.2 (40640000/128256), Serial0/0/1
P 10.1.1.0/30, 1 successors, FD is 40640000
        via 10.1.103.1 (40640000/128256), Serial0/0/0

R3#
```

bb. The most important thing is the two successor routes in the passive state on R3. R1 and R2 are both advertising their connected subnet of 10.1.102.0/30. Because both routes have the same feasible distance of 41024000, both are installed in the topology table. This distance of 41024000 reflects the composite metric of more granular properties about the path to the destination network. Can you view the metrics before the composite metric is computed?

Sí, los anuncios y actualizaciones de rutas EIGRP indican cada una de las métricas de ruta individuales que EIGRP utiliza. Estas métricas de ruta se pueden mostrar con el comando show ip eigrp network / mask.____

cc. Use the **show ip eigrp topology 10.1.102.0/29** command to view the information that EIGRP has received about the route from R1 and R2.

```
R3# show ip eigrp topology 10.1.102.0/29
EIGRP-IPv4 Topology Entry for AS(100)/ID(10.1.3.9) for 10.1.102.0/29
  State is Passive, Query origin flag is 1, 2 Successor(s), FD is
41024000
  Descriptor Blocks:
  10.1.103.1 (Serial0/0/0), from 10.1.103.1, Send flag is 0x0
      Composite metric is (41024000/40512000), route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 40000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
        Originating router is 10.1.1.9
  10.1.203.2 (Serial0/0/1), from 10.1.203.2, Send flag is 0x0
      Composite metric is (41024000/40512000), route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 40000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
        Originating router is 10.1.2.9
R3#
```

The output of this command shows the following information regarding EIGRP:

- The bandwidth metric represents the *minimum* bandwidth among all links comprising the path to the destination network.
- The delay metric represents the *total* delay over the path.
- The minimum MTU represents the smallest MTU along the path.
- If you do not have full knowledge of your network, you can use the hop count information to check how many Layer 3 devices are between the router and the destination network.

Step 4: Observe equal-cost load balancing.

EIGRP produces equal-cost load balancing to the destination network 10.1.102.0/29 from R1. Two equal-cost paths are available to this destination per the topology table output above.

dd. Use the **traceroute 10.1.102.1** command to view the hops from R3 to this R1 IP address. Notice that both R1 and R2 are listed as hops because there are two equal-cost paths and packets can reach this network via either link.

```
R3# traceroute 10.1.102.1
Type escape sequence to abort.
Tracing the route to 10.1.102.1
VRF info: (vrf in name/id, vrf out name/id)
  1 10.1.203.2 24 msec
    10.1.103.1 12 msec
    10.1.203.2 24 msec
R3#
```

Cisco IOS enables Cisco Express Forwarding (CEF), which, by default, performs per-destination load balancing. CEF allows for very rapid switching without the need for route processing. However, if you were to ping the destination network, you would not see load balancing occurring on a packet level because CEF treats the entire series of pings as one flow.

CEF on R3 overrides the per-packet balancing behavior of process switching with per-destination load balancing.

ee. To see the full effect of EIGRP equal-cost load balancing, temporarily disable CEF and route caching so that all IP packets are processed individually and not fast-switched by CEF.

```
R3(config)# no ip cef

R3(config)# interface S0/0/0
R3(config-if)# no ip route-cache
R3(config-if)# interface S0/0/1
R3(config-if)# no ip route-cache
```

Note: Typically, you would not disable CEF in a production network. It is done here only to illustrate load balancing. Another way to demonstrate per-packet load balancing, that does not disable CEF, is to use the per-packet load balancing command **ip load-share per-packet** on outgoing interfaces S0/0/0 and S0/0/1.

ff. Verify load balancing with the **debug ip packet** command, and then ping 10.1.102.1. Like any debug command, **debug ip packet** should be used with caution on a production network. Without any ACL filtering, this command will overwhelm the router's CPU processes in a production environment. Issue the **undebug all** command to stop debug processing. You see output similar to the following:

```
R3# debug ip packet
IP packet debugging is on

R3# ping 10.1.102.1
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 10.1.102.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/36/44
ms
R3#
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/36/44
ms
R3#
*Jun 22 11:39:37.043: IP: tableid=0, s=10.1.203.3 (local),
d=10.1.102.1 (Serial0/0/1), routed via RIB
*Jun 22 11:39:37.043: IP: s=10.1.203.3 (local), d=10.1.102.1
(Serial0/0/1), len 100, sending
*Jun 22 11:39:37.043: IP: s=10.1.203.3 (local), d=10.1.102.1
(Serial0/0/1), len 100, sending full packet
*Jun 22 11:39:37.087: IP: s=10.1.102.1 (Serial0/0/0), d=10.1.203.3,
len 100, input feature, MCI Check(104), rtype 0, forus FALSE,
sendself FALSE, mtu 0, fwdchk FALSE
*Jun 22 11:39:37.087: IP: tableid=0, s=
R3#10.1.102.1 (Serial0/0/0), d=10.1.203.3 (Serial0/0/1), routed via
RIB
*Jun 22 11:39:37.087: IP: s=10.1.102.1 (Serial0/0/0), d=10.1.203.3,
len 100, rcvd 4
*Jun 22 11:39:37.087: IP: s=10.1.102.1 (Serial0/0/0), d=10.1.203.3,
len 100, stop process pak for forus packet
*Jun 22 11:39:37.087: IP: tableid=0, s=10.1.103.3 (local),
d=10.1.102.1 (Serial0/0/0), routed via RIB
*Jun 22 11:39:37.087: IP: s=10.1.103.3 (local), d=10.1.102.1
(Serial0/0/0), len 100, sending
*Jun 22 11:39:37.087: IP: s=10.1.103.3 (local),
R3# d=10.1.102.1 (Serial0/0/0), len 100, sending full packet
*Jun 22 11:39:37.115: IP: s=10.1.102.1 (Serial0/0/0), d=10.1.103.3,
len 100, input feature, MCI Check(104), rtype 0, forus FALSE,
sendself FALSE, mtu 0, fwdchk FALSE

<output omitted>
R3# undebug all
```

Notice that EIGRP load-balances between Serial0/0/0 (s=10.1.103.3) and Serial0/0/1 (s=10.1.203.3). This behavior is part of EIGRP. It can help utilize underused links in a network, especially during periods of congestion.

Step 5: Analyze alternate EIGRP paths not in the topology table.

gg. Issue the **show ip eigrp topology** command on R3 to see successors and feasible successors for each route that R3 has learned through EIGRP..

```
R3# show ip eigrp topology
EIGRP-IPv4 Topology Table for AS(100)/ID(10.1.3.9)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.1.102.0/29, 2 successors, FD is 41024000
        via 10.1.103.1 (41024000/40512000), Serial0/0/0
        via 10.1.203.2 (41024000/40512000), Serial0/0/1
P 10.1.1.8/30, 1 successors, FD is 40640000
        via 10.1.103.1 (40640000/128256), Serial0/0/0
P 10.1.3.0/30, 1 successors, FD is 128256
        via Connected, Loopback31
P 10.1.3.4/30, 1 successors, FD is 128256
        via Connected, Loopback35
P 10.1.3.8/30, 1 successors, FD is 128256
```

```
        via Connected, Loopback39
P 10.1.2.8/30, 1 successors, FD is 40640000
        via 10.1.203.2 (40640000/128256), Serial0/0/1
P 10.1.2.0/30, 1 successors, FD is 40640000
        via 10.1.203.2 (40640000/128256), Serial0/0/1
P 10.1.103.0/29, 1 successors, FD is 40512000
        via Connected, Serial0/0/0
P 10.1.203.0/29, 1 successors, FD is 40512000
        via Connected, Serial0/0/1
P 10.1.1.4/30, 1 successors, FD is 40640000
        via 10.1.103.1 (40640000/128256), Serial0/0/0
P 10.1.2.4/30, 1 successors, FD is 40640000
        via 10.1.203.2 (40640000/128256), Serial0/0/1
P 10.1.1.0/30, 1 successors, FD is 40640000
        via 10.1.103.1 (40640000/128256), Serial0/0/0

R3#
```

Perhaps you expected to see two entries to the R1 and R2 loopback networks in the R3 topology table. Why is there only one entry shown in the topology table?

R3 recibe actualizaciones sobre las interfaces de bucle de retorno R1 de R1 y R2. Aunque ambas rutas tienen el mismo ancho de banda mínimo, la trayectoria a través de R1 tiene un retardo menor que el de R2. R2 incluye el retardo adicional de su enlace serial a R1. Por lo tanto, el par calculado distancia / distancia informada es 40640000/128256 a través de R1 y 41152000/40640000 a través de R2. La distancia calculada a través de R1 (40640000) se convierte en la distancia factible. R3 recibe la ruta a través de R2, pero no entra en la ruta en la tabla de topología EIGRP como un sucesor viable porque la información de ruta debe cumplir la condición de factibilidad para ser insertada en la tabla de topología. La distancia reportada de R2 a R1 es 40640000, que es la misma que la distancia factible de R1 a través de R3. Debido a que el AD de R2 no es estrictamente inferior a R1 FD, la ruta no se inserta en la tabla de topología EIGRP. ____

hh. Issue the **show ip eigrp topology all-links** command to see all routes that R3 has learned through EIGRP. This command shows all entries that EIGRP holds on this router for networks in the topology, including the exit serial interface and IP address of the next hop to each destination network, and the serial number (serno) that uniquely identifies a destination network in EIGRP.

```
R3# show ip eigrp topology all-links
EIGRP-IPv4 Topology Table for AS(100)/ID(10.1.3.9)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.1.102.0/29, 2 successors, FD is 41024000, serno 13
        via 10.1.103.1 (41024000/40512000), Serial0/0/0
        via 10.1.203.2 (41024000/40512000), Serial0/0/1
P 10.1.1.8/30, 1 successors, FD is 40640000, serno 9
        via 10.1.103.1 (40640000/128256), Serial0/0/0
        via 10.1.203.2 (41152000/40640000), Serial0/0/1
P 10.1.3.0/30, 1 successors, FD is 128256, serno 3
        via Connected, Loopback31
P 10.1.3.4/30, 1 successors, FD is 128256, serno 4
        via Connected, Loopback35
P 10.1.3.8/30, 1 successors, FD is 128256, serno 5
        via Connected, Loopback39
```

```
P 10.1.2.8/30, 1 successors, FD is 40640000, serno 16
        via 10.1.203.2 (40640000/128256), Serial0/0/1
        via 10.1.103.1 (41152000/40640000), Serial0/0/0
P 10.1.2.0/30, 1 successors, FD is 40640000, serno 14
        via 10.1.203.2 (40640000/128256), Serial0/0/1
        via 10.1.103.1 (41152000/40640000), Serial0/0/0
P 10.1.103.0/29, 1 successors, FD is 40512000, serno 1
        via Connected, Serial0/0/0
P 10.1.203.0/29, 1 successors, FD is 40512000, serno 2
        via Connected, Serial0/0/1
P 10.1.1.4/30, 1 successors, FD is 40640000, serno 8
        via 10.1.103.1 (40640000/128256), Serial0/0/0
        via 10.1.203.2 (41152000/40640000), Serial0/0/1
P 10.1.2.4/30, 1 successors, FD is 40640000, serno 15
        via 10.1.203.2 (40640000/128256), Serial0/0/1
        via 10.1.103.1 (41152000/40640000), Serial0/0/0
P 10.1.1.0/30, 1 successors, FD is 40640000, serno 7
        via 10.1.103.1 (40640000/128256), Serial0/0/0
        via 10.1.203.2 (41152000/40640000), Serial0/0/1

R3#
```

What is the reported distance to the R1's loopback networks using R1 and R2 as next-hop routers?

La distancia informada de las interfaces de bucle de retorno en R1 de R1 es 128256. La distancia informada a las mismas interfaces de bucle de retorno reportadas a R3 de R2 es 40640000.

ii. Use the **show ip eigrp topology 10.1.2.0/30** command to see the granular view of the alternate paths to 10.1.2.0, including ones with a higher reported distance than the feasible distance.

```
R3# show ip eigrp topology 10.1.2.0/30
IP-EIGRP (AS 100): Topology entry for 10.1.2.0/30
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is
40640000
  Routing Descriptor Blocks:
  10.1.203.2 (Serial0/0/1), from 10.1.203.2, Send flag is 0x0
      Composite metric is (40640000/128256), Route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 25000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
  10.1.103.1 (Serial0/0/0), from 10.1.103.1, Send flag is 0x0
      Composite metric is (41152000/40640000), Route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 45000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
```

When using the **show ip eigrp topology** command, why is the route to 10.1.2.0/30 through R1 (via 10.1.103.1) not listed in the topology table?

La ruta no cumple con la condición de factibilidad. La condición de viabilidad establece que la distancia reportada (RD) debe ser estrictamente menor que la distancia factible (FD) para la ruta que se va a introducir en la tabla de topología. RDR1 (40640000) <FD (40640000) es falso. Por lo tanto, la ruta no se introduce en la tabla de topología. ______________________

What is its reported distance from R1?

RD_{R1} = 40640000

What is its feasible distance?

FD = 40640000

If the R2 Serial0/0/1 interface were shut down, would EIGRP route through R1 to get to 10.1.2.0/30? Why isn't the switch to a new path a quick as it could be?

Sí, pero no hay un sucesor viable, por lo que EIGRP necesitaría consultar a sus vecinos. R1 detectará que el protocolo de enlace está inactivo, no teniendo sucesor pasa al estado activo para esta ruta, consulta a sus vecinos por una ruta y recibe respuestas que le informan de una ruta a través de R1. En este punto el enrutamiento EIGRP usaría el nuevo camino a través de R1.

El cambio al camino a través de R1 no es tan rápido como si R1 tuviera un sucesor viable a 10.1.2.0/30. Sin embargo, tan pronto como R3 se da cuenta de que el enlace está abajo, comenzará a recalcular. El interruptor será muy rápido.

Record your answer, and then experiment by shutting down the R1 S0/0/1 interface while an extended ping is running as described below.

jj. Start a ping with a high repeat count on R3 to the R1 Serial0/0/0 interface 10.1.102.1.

```
R3# ping 10.1.102.1 repeat 10000
```

kk. Enter interface configuration mode on R1 and shut down port Serial0/0/1, which is the direct link from R1 to R3.

```
R1(config)# interface serial 0/0/1
R1(config-if)# shutdown
```

ll. When the adjacency between R1 and R3 goes down, some pings will be lost. After pings are again being successfully received, stop the ping using Ctrl+Shift+^.

```
R3#ping 10.1.102.1 repeat 10000
Type escape sequence to abort.
Sending 10000, 100-byte ICMP Echos to 10.1.102.1, timeout is 2
seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
<output omitted>
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!.!!!!!!
*Jun 22 12:56:45.739: %LINK-3-UPDOWN: Interface Serial0/0/1, changed
state to down!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!
*Jun 22 12:56:45.739: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.1.203.2 (Serial0/0/1) is down: interface down
*Jun 22 12:56:46.739: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to
down!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
<output omitted>
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
!
*Jun 22 12:57:08.723: %LINK-3-UPDOWN: Interface Serial0/0/1, changed
state to up
*Jun 22 12:57:09.723: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/1, changed state to
up!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!
!!!
*Jun 22 12:57:10.003: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.1.203.2 (Serial0/0/1) is up: new
adjacency!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
Success rate is 99 percent (2039/2041), round-trip min/avg/max =
24/31/104 ms
R3#
```

How many packets were dropped?

En este ejemplo, dos paquetes se dejaron caer durante el corte.

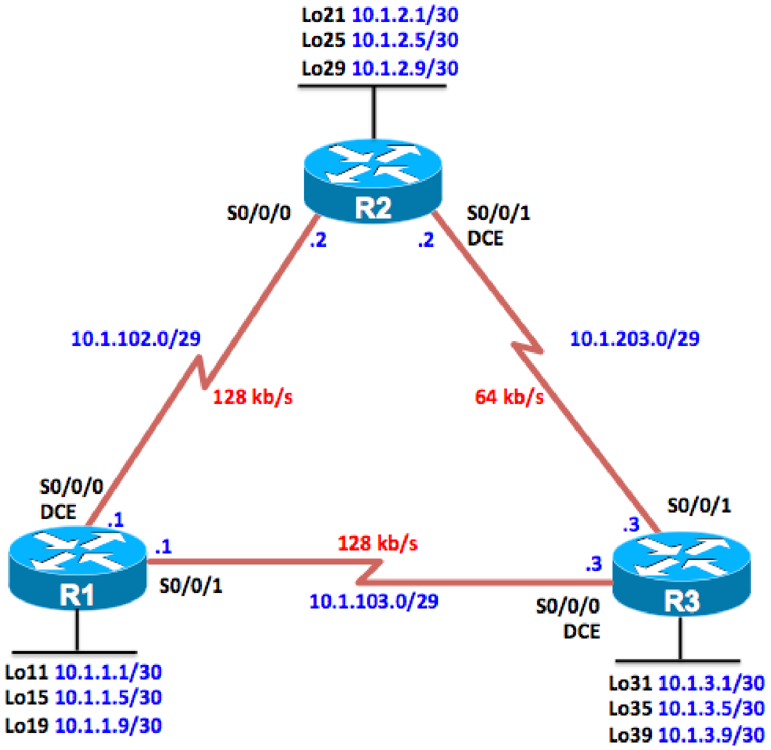
Note: When examining the EIGRP reconvergence speed after deactivating the serial link between R1 and R3, the focus should not be on the count of lost ping packets but rather on the duration of connectivity loss or how long it took to perform a successful cutover. The router waits for up to two seconds for each sent ICMP ECHO request to receive a reply and only then does it send another ECHO request. If the router did not wait for the reply, the count of lost packets would be much higher. Because two packets were lost, the cutover took approximately 4 seconds.

Another factor to consider is that an interface deliberately delays the information about loss of connectivity for 2 seconds to prevent transient link flaps (link going up and down) from introducing instability into the network. If the real speed of EIGRP is to be observed, this delay can be made as short as possible using the command **carrier-delay msec 0** on all serial interfaces.

mm. Issue the **no shutdown** command on the R1 Serial0/0/1 interface before continuing to the next step.

Step 6: Observe unequal-cost load balancing.

Topology showing modified bandwidths as configured in step 6-b.



nn. Review the composite metrics advertised by EIGRP using the **show ip eigrp topology 10.1.2.0/30** command,.

```
R3# show ip eigrp topology 10.1.2.0/30
IP-EIGRP (AS 100): Topology entry for 10.1.2.0/30
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is
40640000
  Routing Descriptor Blocks:
  10.1.203.2 (Serial0/0/1), from 10.1.203.2, Send flag is 0x0
      Composite metric is (40640000/128256), Route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 25000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
  10.1.103.1 (Serial0/0/0), from 10.1.103.1, Send flag is 0x0
      Composite metric is (41152000/40640000), Route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 45000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
```

The reported distance for a loopback network is higher than the feasible distance, so DUAL does not consider it a feasible successor route.

oo. To demonstrate unequal-cost load balancing in your internetwork, upgrade the path to the destination network through R1 with a higher bandwidth. Change the clock rate and bandwidth on the R1, R2, and R3 serial interfaces to 128 kb/s.

```
R1(config)# interface serial 0/0/0
R1(config-if)# bandwidth 128
R1(config-if)# clock rate 128000
R1(config-if)# interface serial 0/0/1
R1(config-if)# bandwidth 128

R2(config)# interface serial 0/0/0
R2(config-if)# bandwidth 128

R3(config)# interface serial 0/0/0
R3(config-if)# clock rate 128000
R3(config-if)# bandwidth 128
```

pp. Issue the **show ip eigrp topology 10.1.2.0/30** command again on R3 to see what has changed.

```
R3# show ip eigrp topology 10.1.2.0/30
EIGRP-IPv4 Topology Entry for AS(100)/ID(10.1.3.9) for 10.1.2.0/30
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is
21152000
  Descriptor Blocks:
  10.1.103.1 (Serial0/0/0), from 10.1.103.1, Send flag is 0x0
      Composite metric is (21152000/20640000), route is Internal
      Vector metric:
        Minimum bandwidth is 128 Kbit
        Total delay is 45000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
        Originating router is 10.1.2.9
  10.1.203.2 (Serial0/0/1), from 10.1.203.2, Send flag is 0x0
      Composite metric is (40640000/128256), route is Internal
      Vector metric:
        Minimum bandwidth is 64 Kbit
        Total delay is 25000 microseconds
        Reliability is 255/255
        Load is 3/255
        Minimum MTU is 1500
        Hop count is 1
        Originating router is 10.1.2.9
R3#
```

After manipulating the bandwidth parameter, the preferred path for R3 to the loopback interfaces of R2 is now through R1. Even though the hop count is two and the delay through R1 is nearly twice that of the R2 path, the higher bandwidth and lower FD results in this being the preferred route.

Note: Hop count is only mentioned to help you visualize the two paths. Hop count is not part of the composite EIGRP metric.

qq. Issue the **show ip route** command to verify that the preferred route to network 10.1.2.0 is through R1 via Serial0/0/0 to next hop 10.1.103.1. There is only one route to this network due to the difference in bandwidth.

```
R3# show ip route eigrp
<output omitted>
      10.0.0.0/8 is variably subnetted, 17 subnets, 3 masks
D        10.1.1.0/30 [90/20640000] via 10.1.103.1, 00:05:09,
Serial0/0/0
D        10.1.1.4/30 [90/20640000] via 10.1.103.1, 00:05:09,
Serial0/0/0
D        10.1.1.8/30 [90/20640000] via 10.1.103.1, 00:05:09,
Serial0/0/0
D        10.1.2.0/30 [90/21152000] via 10.1.103.1, 00:05:09,
Serial0/0/0
D        10.1.2.4/30 [90/21152000] via 10.1.103.1, 00:05:09,
Serial0/0/0
D        10.1.2.8/30 [90/21152000] via 10.1.103.1, 00:05:09,
Serial0/0/0
D        10.1.102.0/29 [90/21024000] via 10.1.103.1, 00:05:09,
Serial0/0/0
R3#
```

rr. The **variance** command is used to enable unequal-cost load balancing. Setting the **variance** command allows you to install multiple loop-free paths with unequal costs into the routing table. EIGRP will always install the successor with the best path. Additional feasible successors are candidates as for unequal-cost paths to be included in the routing table. These candidates must meet two conditions:

- The route must be loop-free, a current feasible successor in the topology table.
- The metric of the route must be lower than the metric of the best route (successor), multiplied by the variance configured on the router.

In the previous output, R3 shows the best path for 10.1.2.0/30 through R1 via 10.1.103.1. Examining the topology table on R3, there is also a feasible successor to this network through R2 via 10.1.203.1.

```
R3# show ip eigrp topology
EIGRP-IPv4 Topology Table for AS(100)/ID(10.1.3.9)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.1.102.0/29, 1 successors, FD is 21024000
        via 10.1.103.1 (21024000/20512000), Serial0/0/0
        via 10.1.203.2 (41024000/20512000), Serial0/0/1
P 10.1.1.8/30, 1 successors, FD is 20640000
        via 10.1.103.1 (20640000/128256), Serial0/0/0
P 10.1.3.0/30, 1 successors, FD is 128256
        via Connected, Loopback31
P 10.1.3.4/30, 1 successors, FD is 128256
        via Connected, Loopback35
P 10.1.3.8/30, 1 successors, FD is 128256
        via Connected, Loopback39
P 10.1.2.8/30, 1 successors, FD is 21152000
        via 10.1.103.1 (21152000/20640000), Serial0/0/0
        via 10.1.203.2 (40640000/128256), Serial0/0/1
P 10.1.2.0/30, 1 successors, FD is 21152000
        via 10.1.103.1 (21152000/20640000), Serial0/0/0
        via 10.1.203.2 (40640000/128256), Serial0/0/1
P 10.1.103.0/29, 1 successors, FD is 20512000
        via Connected, Serial0/0/0
```

```
P 10.1.203.0/29, 1 successors, FD is 40512000
        via Connected, Serial0/0/1
P 10.1.1.4/30, 1 successors, FD is 20640000
        via 10.1.103.1 (20640000/128256), Serial0/0/0
P 10.1.2.4/30, 1 successors, FD is 21152000
        via 10.1.103.1 (21152000/20640000), Serial0/0/0
        via 10.1.203.2 (40640000/128256), Serial0/0/1
P 10.1.1.0/30, 1 successors, FD is 20640000
        via 10.1.103.1 (20640000/128256), Serial0/0/0

R3#
```

ss. Issue the **debug ip eigrp 100** command on R3 to show route events changing in real time. Then, under the EIGRP router configuration on R3, issue the **variance 2** command, which allows unequal-cost load balancing bounded by a maximum distance of (2) × (FD), where FD represents the feasible distance for each route in the routing table. Using 10.1.2.0/30 as an example, (2) x (21152000) = 42304000. The FD of the feasible successor is 40640000 which is less that the variance-modified FD of 42304000. Therefore, the feasible successor route become an additional successor and is added to the routing table.

```
R3# debug ip eigrp 100
EIGRP-IPv4 Route Event debugging is on for AS(100)
R3# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)# router eigrp 100
R3(config-router)# variance 2
R3(config-router)#
*Jun 22 13:16:19.087: EIGRP-IPv4(100): table(default): route
installed for 10.1.102.0/29 (90/21024000) origin(10.1.103.1)
*Jun 22 13:16:19.087: EIGRP-IPv4(100): table(default): route
installed for 10.1.102.0/29 (90/41024000) origin(10.1.203.2)
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): route
installed for 10.1.1.8/30 (90/20640000) origin(10.1.103.1)
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): 10.1.1.8/30
routing table not updated thru 10.1.203.2
*Jun 22 13:16:19.091: EIGRP-IPv4
R3(config-router)#(100): table(default): route installed for
10.1.2.8/30 (90/21152000) origin(10.1.103.1)
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): route
installed for 10.1.2.8/30 (90/40640000) origin(10.1.203.2)
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): route
installed for 10.1.2.0/30 (90/21152000) origin(10.1.103.1)
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): route
installed for 10.1.2.0/30 (90/40640000) origin(10.1.203.2)
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): 10.1
R3(config-router)#.103.0/29 routing table not updated thru 10.1.203.2
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): route
installed for 10.1.1.4/30 (90/20640000) origin(10.1.103.1)
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): 10.1.1.4/30
routing table not updated thru 10.1.203.2
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): route
installed for 10.1.2.4/30 (90/21152000) origin(10.1.103.1)
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): route
installed for 10.1.2.4/30 (90/40640000) origi
R3(config-router)#n(10.1.203.2)
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): route
installed for 10.1.1.0/30 (90/20640000) origin(10.1.103.1)
*Jun 22 13:16:19.091: EIGRP-IPv4(100): table(default): 10.1.1.0/30
routing table not updated thru 10.1.203.2
*Jun 22 13:16:19.103: EIGRP-IPv4(100): table(default): 10.1.102.0/29
- do advertise out Serial0/0/0
```

```
<output omitted>
```

tt. Issue the **show ip route** command again to verify that there are now two routes to network 10.1.2.0. Notice that the two routes have different (unequal) metrics (feasible distances).

```
R3# show ip route eigrp

      10.0.0.0/8 is variably subnetted, 17 subnets, 3 masks
D        10.1.1.0/30 [90/20640000] via 10.1.103.1, 00:05:56,
Serial0/0/0
D        10.1.1.4/30 [90/20640000] via 10.1.103.1, 00:05:56,
Serial0/0/0
D        10.1.1.8/30 [90/20640000] via 10.1.103.1, 00:05:56,
Serial0/0/0
D        10.1.2.0/30 [90/40640000] via 10.1.203.2, 00:05:56,
Serial0/0/1
                     [90/21152000] via 10.1.103.1, 00:05:56,
Serial0/0/0
D        10.1.2.4/30 [90/40640000] via 10.1.203.2, 00:05:56,
Serial0/0/1
                     [90/21152000] via 10.1.103.1, 00:05:56,
Serial0/0/0
D        10.1.2.8/30 [90/40640000] via 10.1.203.2, 00:05:56,
Serial0/0/1
                     [90/21152000] via 10.1.103.1, 00:05:56,
Serial0/0/0
D        10.1.102.0/29 [90/41024000] via 10.1.203.2, 00:05:56,
Serial0/0/1
                       [90/21024000] via 10.1.103.1, 00:05:56,
Serial0/0/0
R3#
```

uu. These unequal-cost routes also show up in the EIGRP topology table as an additional successor. Use the **show ip eigrp topology** command to verify this. Notice there are two successor routes with different (unequal) feasible distances.

```
R3# show ip eigrp topology
EIGRP-IPv4 Topology Table for AS(100)/ID(10.1.3.9)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 10.1.102.0/29, 2 successors, FD is 21024000
        via 10.1.103.1 (21024000/20512000), Serial0/0/0
        via 10.1.203.2 (41024000/20512000), Serial0/0/1
P 10.1.1.8/30, 1 successors, FD is 20640000
        via 10.1.103.1 (20640000/128256), Serial0/0/0
P 10.1.3.0/30, 1 successors, FD is 128256
        via Connected, Loopback31
P 10.1.3.4/30, 1 successors, FD is 128256
        via Connected, Loopback35
P 10.1.3.8/30, 1 successors, FD is 128256
        via Connected, Loopback39
P 10.1.2.8/30, 2 successors, FD is 21152000
        via 10.1.203.2 (40640000/128256), Serial0/0/1
        via 10.1.103.1 (21152000/20640000), Serial0/0/0
P 10.1.2.0/30, 2 successors, FD is 21152000
        via 10.1.203.2 (40640000/128256), Serial0/0/1
        via 10.1.103.1 (21152000/20640000), Serial0/0/0
P 10.1.103.0/29, 1 successors, FD is 20512000
        via Connected, Serial0/0/0
```

```
P 10.1.203.0/29, 1 successors, FD is 40512000
        via Connected, Serial0/0/1
P 10.1.1.4/30, 1 successors, FD is 20640000
        via 10.1.103.1 (20640000/128256), Serial0/0/0
P 10.1.2.4/30, 2 successors, FD is 21152000
        via 10.1.203.2 (40640000/128256), Serial0/0/1
        via 10.1.103.1 (21152000/20640000), Serial0/0/0
P 10.1.1.0/30, 1 successors, FD is 20640000
        via 10.1.103.1 (20640000/128256), Serial0/0/0

R3#
```

vv. Load balancing over serial links occurs in blocks of packets, the number of which are recorded in the routing table's detailed routing information. Use the **show ip route 10.1.2.0** command to get a detailed view of how traffic is shared between the two links. The traffic share counters represent the ratio of traffic over the shared paths. In this case the ratio is 48:25 or about 2-to-1. The path through R1, 10.1.103.1, will be sent twice as much traffic as the path through R2, 10.1.203.2. A traffic share count of 1 on all routes indicates equal cost load balancing. If the traffic share count is 0, the path is not in use.

```
R3# show ip route 10.1.2.0
Routing entry for 10.1.2.0/30
  Known via "eigrp 100", distance 90, metric 21152000, type internal
  Redistributing via eigrp 100
  Last update from 10.1.203.2 on Serial0/0/1, 00:10:11 ago
  Routing Descriptor Blocks:
    10.1.203.2, from 10.1.203.2, 00:10:11 ago, via Serial0/0/1
      Route metric is 40640000, traffic share count is 25
      Total delay is 25000 microseconds, minimum bandwidth is 64 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 3/255, Hops 1
  * 10.1.103.1, from 10.1.103.1, 00:10:11 ago, via Serial0/0/0
      Route metric is 21152000, traffic share count is 48
      Total delay is 45000 microseconds, minimum bandwidth is 128
Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 2
R3#
```

ww. Check the actual load balancing using the **debug ip packet** command. Ping from R3 to 10.1.2.1 with a high enough repeat count to view the load balancing over both paths. In the case above, the traffic share is 25 packets routed to R2 to every 48 packets routed to R1.

To filter the debug output to make it more useful, use the following extended access list.

```
R3(config)# access-list 100 permit icmp any any echo
R3(config)# end

R3# debug ip packet 100
IP packet debugging is on for access list 100

R3# ping 10.1.2.1 repeat 50

Type escape sequence to abort.
Sending 50, 100-byte ICMP Echos to 10.1.2.1, timeout is 2 seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
*Jun 22 13:48:23.598: IP: tableid=0, s=10.1.103.3 (local), d=10.1.2.1
(Serial0/0/0), routed via RIB
*Jun 22 13:48:23.598: IP: s=10.1.103.3 (local), d=10.1.2.1
(Serial0/0/0), len 100, sending
```

```
*Jun 22 13:48:23.598: IP: s=10.1.103.3 (local), d=10.1.2.1
(Serial0/0/0), len 100, sending full packet
*Jun 22 13:48:23.626: IP: tableid=0, s=10.1.103.3 (local), d=10.1.2.1
(Serial0/0/0), routed via RIB
*Jun 22 13:48:23.626: IP: s=10.1.103.3 (local), d=10.1.2.1
(Serial0/0/0), len 100, sending
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
*Jun 22 13:48:23.626: IP: s=10.1.103.3 (local), d=10.1.2.1
(Serial0/0/0), len 100, sending full packet
*Jun 22 13:48:23.654: IP: tableid=0, s=10.1.103.3 (local), d=10.1.2.1
(Serial0/0/0), routed via RIB
*Jun 22 13:48:23.654: IP: s=10.1.103.3 (local), d=10.1.2.1
(Serial0/0/0), len 100, sending
*Jun 22 13:48:23.654: IP: s=10.1.103.3 (local), d=10.1.2.1
(Serial0/0/0), len 100, sending full packet
!
```

R3 just switched to load-share the outbound ICMP packets to Serial0/0/1.

```
!
*Jun 22 13:48:24.954: IP: s=10.1.203.3 (local), d=10.1.2.1
(Serial0/0/1), len 100, sending
*Jun 22 13:48:24.954: IP: s=10.1.203.3 (local), d=10.1.2.1
(Serial0/0/1), len 100, sending full packet
*Jun 22 13:48:24.982: IP: tableid=0, s=10.1.203.3 (local), d=10.1.2.1
(Serial0/0/1), routed via RIB
*Jun 22 13:48:24.982: IP: s=10.1.203.3 (local), d=10.1.2.1
(Serial0/0/1), len 100, sending
*Jun 22 13:48:24.982: IP: s=10.1.203.3 (local), d=10.1.2.1
(Serial0/0/1
R3#), len 100, sending full packet
R3#
<output omitted>
```

Note: If a deliberate metric manipulation is necessary on a router to force it to prefer one interface over another for EIGRP-discovered routes, it is recommended to use the interface-level command "delay" for these purposes. While the "bandwidth" command can also be used to influence the metrics of EIGRP-discovered routes through a particular interface, it is discouraged because the "bandwidth" will also influence the amount of bandwidth reserved for EIGRP packets and other IOS subsystems as well. The "delay" parameter specifies the value of the interface delay that is used exclusively by EIGRP to perform metric calculations and does not influence any other area of IOS operation.

xx. Issue the **show ip protocols** command will verify the **variance** parameter and the number of maximum paths used by EIGRP. By default, EIGRP will use a maximum of 4 paths for load balancing. This value can be changed using the **maximum-path** EIGRP configuration command.

```
R3# show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "application"
  Sending updates every 0 seconds
  Invalid after 0 seconds, hold down 0, flushed after 0
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Maximum path: 32
  Routing for Networks:
  Routing Information Sources:
    Gateway         Distance      Last Update
  Distance: (default is 4)
```

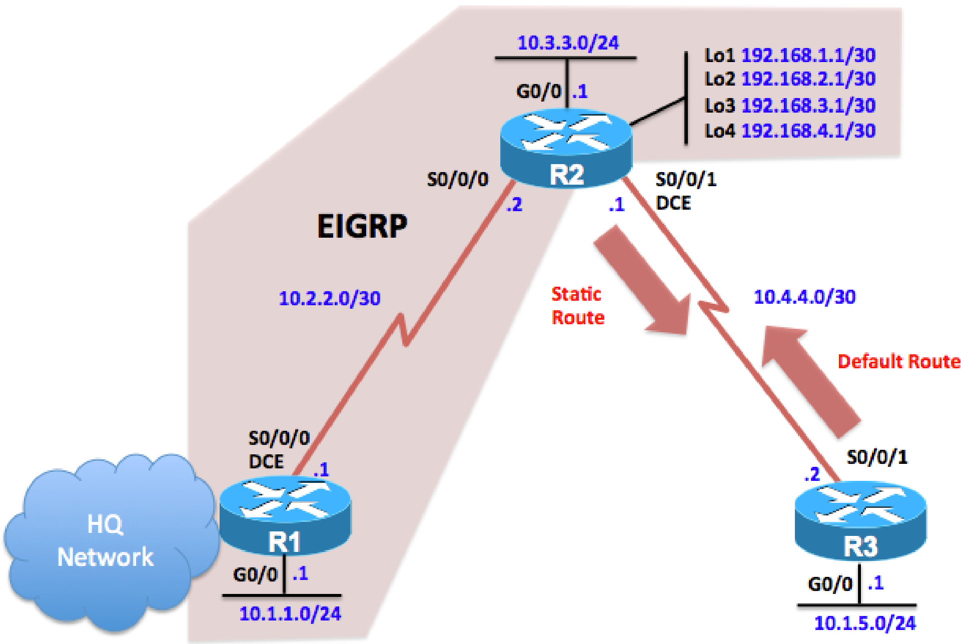
```
Routing Protocol is "eigrp 100"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP-IPv4 Protocol for AS(100)
    Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
    NSF-aware route hold timer is 240
    Router-ID: 10.1.3.9
    Topology : 0 (base)
      Active Timer: 3 min
      Distance: internal 90 external 170
      Maximum path: 4
      Maximum hopcount 100
      Maximum metric variance 2

  Automatic Summarization: disabled
  Maximum path: 4
  Routing for Networks:
    10.0.0.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.1.103.1            90      00:39:03
    10.1.203.2            90      00:39:03
  Distance: internal 90 external 170

R3#
```

Chapter 2 Lab 2-2, EIGRP Stub Routing

Topology



Objectives

- Configure basic EIGRP.
- Configure EIGRP stub routing options.
- Verify EIGRP stub routing options

Background

To improve network stability and reduce resource utilization on the HQ network you have decided to configure one of the branch routers, R2 as an EIGRP stub router.

Note: This lab uses Cisco 1941 routers with Cisco IOS Release 15.4 with IP Base. The switches are Cisco WS-C2960-24TT-L with Fast Ethernet interfaces, therefore the router will use routing metrics associated with a 100 Mb/s interface. Depending on the router or switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 3 routers (Cisco IOS Release 15.2 or comparable)
- 3 switches (LAN interfaces)
- Serial and Ethernet cables

Step 0: Suggested starting configurations.

yy. Apply the following configuration to each router along with the appropriate **hostname**. The **exec-timeout 0 0** command should only be used in a lab environment.

```
Router(config)# no ip domain-lookup
Router(config)# line con 0
Router(config-line)# logging synchronous
Router(config-line)# exec-timeout 0 0
```

Step 1: Configure the addressing and serial links.

zz. Using the addressing scheme in the diagram, configure the interfaces on each router.

```
R1(config)# interface gigabitethernet 0/0
R1(config-if)# ip address 10.1.1.1 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)# exit
R1(config)# interface serial 0/0/0
R1(config-if)# ip address 10.2.2.1 255.255.255.252
R1(config-if)# clock rate 64000
R1(config-if)# no shutdown
R1(config-if)# exit

R2(config)# interface serial 0/0/0
R2(config-if)# ip address 10.2.2.2 255.255.255.252
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface gigabitethernet 0/0
R2(config-if)# ip address 10.3.3.1 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface serial 0/0/1
R2(config-if)# ip address 10.4.4.1 255.255.255.252
R2(config-if)# clockrate 64000
```

```
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Loopback1
R2(config-if)# ip address 192.168.1.1 255.255.255.252
R2(config-if)# exit
R2(config)# interface Loopback2
R2(config-if)# ip address 192.168.2.1 255.255.255.252
R2(config-if)# exit
R2(config)# interface Loopback3
R2(config-if)# ip address 192.168.3.1 255.255.255.252
R2(config-if)# exit
R2(config)# interface Loopback4
R2(config-if)# ip address 192.168.4.1 255.255.255.252
R2(config-if)# exit

R3(config)# interface serial 0/0/1
R3(config-if)# ip address 10.4.4.2 255.255.255.252
R3(config-if)# no shutdown
R3(config-if)# exit
R3(config)# interface gigabitethernet 0/0
R3(config-if)# ip address 10.1.5.1 255.255.255.0
R3(config-if)# no shutdown
R3(config-if)# exit
```

aaa. Verify connectivity by pinging across each of the local networks connected to each router.

bbb. Issue the **show ip interface brief** command on each router. This command displays a brief listing of the interfaces, their status, and their IP addresses. Router R2 is shown as an example.

```
R2# show ip interface brief
Interface                  IP-Address      OK? Method Status
Protocol
Embedded-Service-Engine0/0 unassigned      YES unset
administratively down down
GigabitEthernet0/0         10.3.3.1        YES manual up
up
Serial0/0/0                10.2.2.2        YES manual up
up
Serial0/0/1                10.4.4.1        YES manual up
up
R2#
```

Step 2: Configure EIGRP.

ccc. Enable EIGRP AS 100 for all interfaces on R1 and R2. For your reference, these are the commands which can be used:

```
R1(config)# router eigrp 100
R1(config-router)# network 10.0.0.0

R2(config)# router eigrp 100
R2(config-router)# network 10.0.0.0
R2(config-router)# network 192.168.0.0 0.0.255.255
```

ddd. Summarize R2's loopback interfaces in its EIGRP update to R1 using manual summarization.

```
R2(config)# interface serial 0/0/0
R2(config-if)# ip summary-address eigrp 100 192.168.0.0 255.255.248.0
```

eee. Configure a static route on R2 to R3's LAN. Configure a default static route on R3 forwarding all traffic to R2.

```
R2(config)# ip route 10.1.5.0 255.255.255.0 10.4.4.2

R3(config)# ip route 0.0.0.0 0.0.0.0 10.4.4.1
```

fff. Verify that R2 and R3 can ping the other's LAN intefaces.

```
R2# ping 10.1.5.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.5.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/28/28
ms
R2#

R3# ping 10.3.3.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.3.3.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/28/28
ms
R3#
```

ggg. Verify the EIGRP the neighbor relationship between R1 and R2 with the **show ip eigrp neighbors** command. Verify that R1 is receiving a summary route for R2's loopback networks. The output for R2 is as follows.

```
R2# show ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT
RTO  Q  Seq
                                                   (sec)         (ms)
Cnt Num
0   10.2.2.1                Se0/0/0                  12 00:51:26  363
2178  0  9
R2#
```

hhh. Examine R1's routing table with the **show ip route eigrp** command.

```
R1# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set
```

```
       10.0.0.0/8 is variably subnetted, 6 subnets, 3 masks
C         10.1.1.0/24 is directly connected, GigabitEthernet0/0
L         10.1.1.1/32 is directly connected, GigabitEthernet0/0
C         10.2.2.0/30 is directly connected, Serial0/0/0
L         10.2.2.1/32 is directly connected, Serial0/0/0
D         10.3.3.0/30 [90/2172416] via 10.2.2.2, 00:52:58, Serial0/0/0
D         10.4.4.0/30 [90/2681856] via 10.2.2.2, 00:52:58, Serial0/0/0
D      192.168.0.0/21 [90/2297856] via 10.2.2.2, 00:47:02, Serial0/0/0
R1#
```

Does R1 have a route to R3's LAN? Why or why not.

El router #3 no implementa configuracion EIGRP, y el router #1 no presenta una ruta establecida a la dirección 10.1.5.0/24____

____

Step 3: Configure and verify EIGRP stub routing.

iii. EIGRP stub routing feature enable you to limit the EIGRP Query messages scope in the network. Routers configured as stubs do not forward EIGRP learned routes to other neighbors.

Use the **eigrp stub** command to configure a router as a stub where the router directs all IP traffic to a distribution router.

The **eigrp stub** command can be modified with several options, and these options can be used in any combination except for the **receive-only** keyword. The **receive-only** keyword will restrict the router from sharing any of its routes with any other router in that EIGRP autonomous system, and the **receive-only** keyword will not permit any other option to be specified because it prevents any type of route from being sent. The four other optional keywords (**connected**, **static**, **summary**, and **redistributed**) can be used in any combination but cannot be used with the **receive-only** keyword.

If any of these five keywords is used with the **eigrp stub** command, only the route types specified by the particular keyword(s) will be sent. Route types specified by the remaining keywords will not be sent.

The **connected** keyword permits the EIGRP stub routing feature to send connected routes. If the connected routes are not covered by a network statement, it may be necessary to redistribute connected routes with the redistribute connected command under the EIGRP process. *This option is enabled by default*.

The **static** keyword permits the EIGRP stub routing feature to send static routes. Without the configuration of this option, EIGRP will not send any static routes, including internal static routes that normally would be automatically redistributed. It will still be necessary to redistribute static routes with the redistribute static command.

The **summary** keyword permits the EIGRP stub routing feature to send summary routes. Summary routes can be created manually with the summary address command or automatically at a major network border router with the auto-summary command enabled. *This option is enabled by default*.

The **redistributed** keyword permits the EIGRP stub routing feature to send other routing protocols and autonomous systems. Without the configuration of this option, EIGRP will not advertise redistributed routes.

Note: There is one more keyword the **leak-map** option. The **leak-map** keyword permits the EIGRP stub routing feature to reference a leak map that identifies routes that are allowed to be advertised on an EIGRP stub router that would normally have been suppressed.

Configure R2 as a stub router using the default **eigrp stub** command.

```
R2(config)# router eigrp 100
R2(config-router)# eigrp stub ?
  connected       Do advertise connected routes
  leak-map        Allow dynamic prefixes based on the leak-map
  receive-only    Set receive only neighbor
  redistributed   Do advertise redistributed routes
  static          Do advertise static routes
  summary         Do advertise summary routes
  <cr>
 R2(config-router)# eigrp stub
*Jul 22 00:41:02.667: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.2.2.1 (Serial0/0/0) is down: peer info changed
R2(config-router)#
*Jul 22 00:41:03.899: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.2.2.1 (Serial0/0/0) is up: new adjacency
R2(config-router)
```

jjj. Examine the EIGRP section in R2's running-config. What EIGRP stub options are implemented by default?

```
R2# show running-config | section eigrp
 ip summary-address eigrp 100 192.168.0.0 255.255.248.0
router eigrp 100
 network 10.0.0.0
 network 192.168.0.0 0.0.255.255
 eigrp stub connected summary
R2#
```

What EIGRP stub options are implemented by default?

Se implementa por predeterminada las opciones de conexión y resumen. ________________

____

kkk.Examine the EIGRP routes in R1's routing table.

```
R1# show ip route eigrp

      10.0.0.0/8 is variably subnetted, 6 subnets, 3 masks
D        10.3.3.0/24 [90/2172416] via 10.2.2.2, 00:10:34, Serial0/0/0
D        10.4.4.0/30 [90/2681856] via 10.2.2.2, 00:10:34, Serial0/0/0
D     192.168.0.0/21 [90/2297856] via 10.2.2.2, 00:10:34, Serial0/0/0
R1#
```

Notice that R1 shows EIGRP routes for R2's connected networks and R2's 192.16.0.0/21 summary route

lll. Issue the **show ip eigrp neighbors detail** command to verify that R1 sees R2 as a stub router.

```
R1# show ip eigrp neighbors detail
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT
RTO  Q  Seq
                                                   (sec)         (ms)
Cnt Num
```

```
0   10.2.2.2                Se0/0/0                  14 00:21:37   20
120  0  15
   Version 16.0/2.0, Retrans: 0, Retries: 0, Prefixes: 3
   Topology-ids from peer - 0
   Stub Peer Advertising (CONNECTED SUMMARY ) Routes
   Suppressing queries
Max Nbrs: 0, Current Nbrs: 0
R1#
```

Step 4: Configure and verify EIGRP stub routing options static, connected and summary.

mmm. Modify R2's stub routing to also include its static route in its EIGRP update to R1. It is necessary to also include the redistribute static command.

```
R2(config)# router eigrp 100
R2(config-router)# redistribute static
R2(config-router)# eigrp stub static
*Jul 22 01:08:39.891: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.2.2.1 (Serial0/0/0) is down: peer info changed
*Jul 22 01:08:40.919: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.2.2.1 (Serial0/0/0) is up: new adjacency
```

With each change of the EIGRP stub settings, reestablishment of the EIGRP neighbor session is required.

nnn. Examine R1's EIGRP routes using the **show ip route eigrp** command.

```
R1# show ip route eigrp

      10.0.0.0/8 is variably subnetted, 5 subnets, 3 masks
D EX     10.1.5.0/24 [170/2681856] via 10.2.2.2, 00:00:23,
Serial0/0/0
R1#
```

Why does R1 only have R2's static route to R3's LAN? What do you need to do so R1 includes the previous EIGRP routes?

Cuando introducimos el comando **eigrp stub static** deshabilita las opciones por defecto de coneccion y resumen. ____

____

ooo. R2's stub configuration can be verified using the **show ip eigrp neighbors detail** command on R1 and **show running-config | section eigrp** on R2.

```
R1# show ip eigrp neighbors detail
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT
RTO  Q  Seq
                                                   (sec)         (ms)
Cnt Num
0   10.2.2.2                Se0/0/0                  13 00:14:45   22
132  0  20
   Version 16.0/2.0, Retrans: 0, Retries: 0, Prefixes: 1
   Topology-ids from peer - 0
   Stub Peer Advertising (STATIC ) Routes
   Suppressing queries
Max Nbrs: 0, Current Nbrs: 0
R1#
```

```
R2# show running-config | section eigrp
 ip summary-address eigrp 100 192.168.0.0 255.255.248.0
router eigrp 100
 network 10.0.0.0
 network 192.168.0.0 0.0.255.255
 redistribute static
 eigrp stub static
R2#
```

ppp. Configure R2 EIGRP stub routing to include the connected, summary and static options.

```
R2(config)# router eigrp 100
R2(config-router)# eigrp stub connected summary static
*Jul 22 01:29:15.411: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.2.2.1 (Serial0/0/0) is down: peer info changed
*Jul 22 01:29:17.195: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.2.2.1 (Serial0/0/0) is up: new adjacency
```

qqq. Examine R1's routing table and notice R1 is now sending its connected, summarized and static routes to R1.

```
R1# show ip route eigrp

      10.0.0.0/8 is variably subnetted, 7 subnets, 3 masks
D EX     10.1.5.0/24 [170/2681856] via 10.2.2.2, 00:02:11,
Serial0/0/0
D        10.3.3.0/24 [90/2172416] via 10.2.2.2, 00:02:11, Serial0/0/0
D        10.4.4.0/30 [90/2681856] via 10.2.2.2, 00:02:11, Serial0/0/0
D      192.168.0.0/21 [90/2297856] via 10.2.2.2, 00:02:11, Serial0/0/0
R1#
```

rrr. Verify R2's modified stub configuration using the **show ip eigrp neighbors detail** command on R1.

```
R1# show ip eigrp neighbor detail
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT
RTO  Q  Seq
                                                   (sec)         (ms)
Cnt Num
0   10.2.2.2                Se0/0/0                  11 00:02:37 1289
5000  0  22
   Version 16.0/2.0, Retrans: 0, Retries: 0, Prefixes: 4
   Topology-ids from peer - 0
   Stub Peer Advertising (CONNECTED STATIC SUMMARY ) Routes
   Suppressing queries
Max Nbrs: 0, Current Nbrs: 0
R1#
```

sss. Examine the change to R2's running-configuration using the **show running-config | section eigrp** command.

```
R2# show running-config | section eigrp
 ip summary-address eigrp 100 192.168.0.0 255.255.248.0
router eigrp 100
 network 10.0.0.0
 network 192.168.0.0 0.0.255.255
 redistribute static
 eigrp stub connected static summary
R2#
```

ttt. At this point R1 and R3 should now be able to ping the other's LAN.

```
R1# ping 10.1.5.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.5.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/56/56
ms
R1#

R3# ping 10.1.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/55/56
ms
R3#
```

Step 5: Configure and verify EIGRP stub routing option receive-only.

uuu. The **receive-only** option prevents the stub router from sharing any of its routes with any other router in the EIGRP AS. This option does not permit any other option to be included. The option is not as common as the previous options. Examples of this the **receive-only** option include when the router has a single interface of if NAT/PAT is configured with host hidden behind the stub router.

```
R2(config)# router eigrp 100
R2(config-router)# eigrp stub receive-only
*Jul 22 01:51:37.995: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.2.2.1 (Serial0/0/0) is down: peer info changed
*Jul 22 01:51:41.115: %SYS-5-CONFIG_I: Configured from console by
console
*Jul 22 01:51:41.843: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor
10.2.2.1 (Serial0/0/0) is up: new adjacency
```

What EIGRP routes do you expect R1 to have in it's routing table?

El router #1 no resivira direcciones EIGRP del router #2 ________________________________

____

vvv. Issue the **show ip route eigrp** command to examine the EIGRP routes R1 is receiving from R2.

```
R1# show ip route eigrp
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

R1#
```

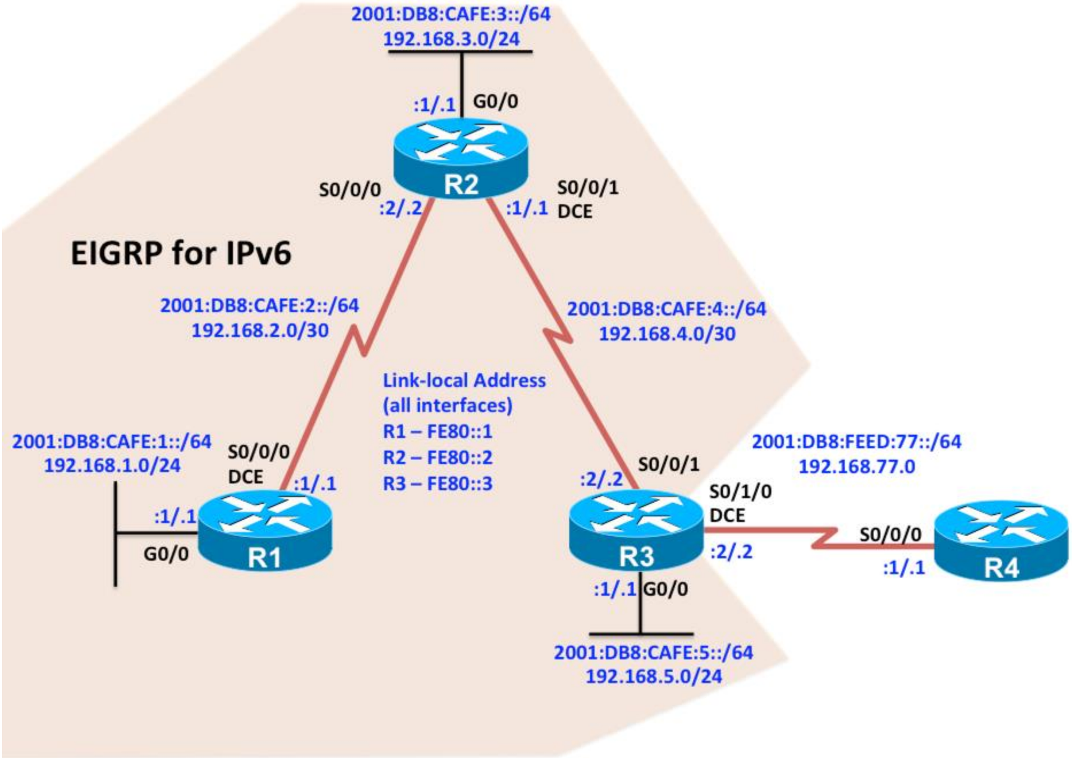
Notice that R1 does not receive any EIGRP routes from R2.

www. Issue the **show ip eigrp neighbor detail** command on R1 to verify it sees R2 as a receive-only stub router .

```
R1# show ip eigrp neighbor detail
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT
RTO  Q  Seq
                                                   (sec)         (ms)
Cnt Num
0   10.2.2.2                Se0/0/0                  11 00:01:58   19
114  0  24
   Version 16.0/2.0, Retrans: 0, Retries: 0
   Topology-ids from peer - 0
   Receive-Only Peer Advertising (No) Routes
   Suppressing queries
Max Nbrs: 0, Current Nbrs: 0
R1#
```

Chapter 2 Lab 2-4, Named EIGRP Configuration

Topology



Objectives

- Configure Named EIGRP for IPv4 and IPv6.
- Verify Named EIGRP configuration.
- Configure and verify passive routes Named EIGRP configuration.
- Configure and verify default route using Named EIGRP configuration.

Background

What is known as "classic" EIGRP requires separate EIGRP configuration modes and commands for IPv4 and IPv6. Each process is configured separately, **router eigrp** *as-number* for IPv4 and **ipv6 router eigrp** *as-number* for IPv6.

Named EIGRP uses the address family (AF) feature to unify the configuration process when implementing both IPv4 and IPv6. In this lab, you will configure named EIGRP for IPv4 and IPv6.

Note: This lab uses Cisco 1941 routers with Cisco IOS Release 15.4 with IP Base. The switches are Cisco WS-C2960-24TT-L with Fast Ethernet interfaces, therefore the router will use routing metrics associated with a 100 Mb/s interface. Depending on the router or switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 4 routers (Cisco IOS Release 15.2 or comparable)
- 3 switches (LAN interfaces)
- Serial and Ethernet cables

Step 0: Suggested starting configurations.

xxx.Apply the following configuration to each router along with the appropriate **hostname**. The **exec-timeout 0 0** command should only be used in a lab environment.

```
Router(config)# no ip domain-lookup
Router(config)# line con 0
Router(config-line)# logging synchronous
Router(config-line)# exec-timeout 0 0
```

Step 1: Configure the addressing and serial links.

yyy.Using the topology, configure the IPv4 and IPv6 addresses on the interfaces of each router.

```
R1(config)# interface GigabitEthernet0/0
R1(config-if)# ip address 192.168.1.1 255.255.255.0
R1(config-if)# ipv6 address FE80::1 link-local
R1(config-if)# ipv6 address 2001:DB8:CAFE:1::1/64
R1(config-if)# no shutdown
R1(config-if)# exit
R1(config)# interface Serial0/0/0
R1(config-if)# ip address 192.168.2.1 255.255.255.252
R1(config-if)# ipv6 address FE80::1 link-local
R1(config-if)# ipv6 address 2001:DB8:CAFE:2::1/64
R1(config-if)# clock rate 64000
R1(config-if)# no shutdown

R2(config)# interface GigabitEthernet0/0
R2(config-if)# ip address 192.168.3.1 255.255.255.0
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:3::1/64
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Serial0/0/0
R2(config-if)# ip address 192.168.2.2 255.255.255.252
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:2::2/64
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Serial0/0/1
R2(config-if)# ip address 192.168.4.1 255.255.255.252
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:4::1/64
R2(config-if)# clock rate 64000
R2(config-if)# no shutdown

R3(config)# interface GigabitEthernet0/0
R3(config-if)# ip address 192.168.5.1 255.255.255.0
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:CAFE:5::1/64
R3(config-if)# no shutdown
R3(config-if)# exit
```

```
R3(config)# interface Serial0/0/1
R3(config-if)# ip address 192.168.4.2 255.255.255.252
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:CAFE:4::2/64
R3(config-if)# no shutdown
R3(config-if)# exit
R3(config)# interface Serial0/1/0
R3(config-if)# ip address 192.168.77.2 255.255.255.0
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:FEED:77::2/64
R3(config-if)# clock rate 64000
R3(config-if)# no shutdown
R3(config-if)#

R4(config)# interface Serial0/0/0
R4(config-if)# ip address 192.168.77.1 255.255.255.0
R4(config-if)# ipv6 address FE80::4 link-local
R4(config-if)# ipv6 address 2001:DB8:FEED:77::1/64
R4(config-if)# no shutdown
R4(config-if)# exit
R4(config)# ipv6 route 2001:DB8:CAFE::/48 2001:DB8:FEED:77::2
R4(config)# ip route 0.0.0.0 0.0.0.0 192.168.77.2
R4(config)#
```

zzz.Verify connectivity by pinging across each of the local networks connected to each router.

aaaa. Issue the **show ip interface brief** and **show ipv6 interface brief** commands on each router. This command displays a brief listing of the interfaces, their status, and their IP addresses. Router R1 is shown as an example.

```
R1# show ip interface brief
Interface                  IP-Address      OK? Method Status
Protocol
Embedded-Service-Engine0/0 unassigned      YES unset
administratively down down
GigabitEthernet0/0         192.168.1.1     YES manual up
up
GigabitEthernet0/1         unassigned      YES unset
administratively down down
Serial0/0/0                192.168.2.1     YES manual up
up
Serial0/0/1                unassigned      YES unset
administratively down down
R1# show ipv6 interface brief
Em0/0                  [administratively down/down]
    unassigned
GigabitEthernet0/0     [up/up]
    FE80::1
    2001:DB8:CAFE:1::1
GigabitEthernet0/1     [administratively down/down]
    unassigned
Serial0/0/0            [up/up]
    FE80::1
    2001:DB8:CAFE:2::1
Serial0/0/1            [administratively down/down]
```

```
    unassigned
R1#
```

Step 2: Configure Named EIGRP for IPv4 on R1.

a. Named EIGRP is organized in an hierarchical manner. Configuration for each routing protocol, EIGRP for IPv4 and EIGRP for IPv6 is done within its own address family. To configure named EIGRP configuration use the **router eigrp** *virtual-instance-name* command in global configuration mode. The virtual-instance-names do not have to match between neighbors.

Note: IPv6 unicast routing must be enabled prior to configuring the IPv6 address family.

```
R1(config)# ipv6 unicast-routing
R1(config)# router eigrp DUAL-STACK
R1(config-router)#
```

b. EIGRP doesn't start until at least one address family has been defined (IPv4 or IPv6). The address family command starts the EIGRP protocol (IPv4 or IPv6) for the defined autonomous system.

To configure the IPv4 address family and autonomous system you use the **address-family ipv4 unicast autonomous-system** command. This command puts you into the address family configuration mode. Issue the **address-family ?** command see the two address families available. After configuring the IPv4 address family for EIGRP use the **?** to see what commands available in address family configuration mode such as the **af-interface**, **eigrp**, and **network** commands.

```
R1(config-router)# address-family ?
  ipv4  Address family IPv4
  ipv6  Address family IPv6

R1(config-router)# address-family ipv4 unicast autonomous-system 4
R1(config-router-af)# ?
Address Family configuration commands:
  af-interface          Enter Address Family interface configuration
  default               Set a command to its defaults
  eigrp                 EIGRP Address Family specific commands
  exit-address-family   Exit Address Family configuration mode
  help                  Description of the interactive help system
  maximum-prefix        Maximum number of prefixes acceptable in
aggregate
  metric                Modify metrics and parameters for address
advertisement
  neighbor              Specify an IPv4 neighbor router
  network               Enable routing on an IP network
  no                    Negate a command or set its defaults
  shutdown              Shutdown address family
  timers                Adjust peering based timers
  topology              Topology configuration mode

R1(config-router-af)#
```

c. In address family configuration mode you can enable EIGRP for specific interfaces and define other general parameters such as the router ID and stub routing. Issue the **eigrp ?** to see the available options configured using the **eigrp** command. Use the **eigrp router-id** command to configure the EIGRP router ID for the IPv4 address family.

```
R1(config-router-af)# eigrp ?
  default-route-tag       Default Route Tag for the Internal Routes
  log-neighbor-changes    Enable/Disable EIGRP neighbor logging
  log-neighbor-warnings   Enable/Disable EIGRP neighbor warnings
  router-id               router id for this EIGRP process
  stub                    Set address-family in stubbed mode

R1(config-router-af)# eigrp router-id 1.1.1.1
R1(config-router-af)#
```

d. While still in the address family configuration mode for IPv4, use the **network** command to enable EIGRP on the interfaces. These are the same **network** commands used in "classic" EIGRP for IPv4.

```
R1(config-router-af)# network 192.168.1.0
R1(config-router-af)# network 192.168.2.0 0.0.0.3
R1(config-router-af)#
```

e. Exit the IPv4 address family configuration mode using the **exit-address-family** command or the shorter **exit** command. Notice that you are still in named EIGRP configuration mode.

```
R1(config-router-af)# exit-address-family
R1(config-router)#
```

Step 3: Configure Named EIGRP for IPv6 on R1.

a. Configure the IPv6 address family using the autonomous system (process ID) of 6. Use the **?** the view the command options available under each mode and for some of the commands. There is no requirement for the AS numbers to match between the IPv4 and IPv6 address families, but they must match their neighbors' AS. In this example, routers R2 and R3 must use AS 4 for the IPv4 address family and AS 6 for the IPv6 address family.

```
R1(config-router)# address-family ipv6 unicast autonomous-system 6
R1(config-router-af)#
```

b. Use the **eigrp router-id** command to configure the EIGRP router ID for the IPv4 address family. The IPv6 router ID does not have to match the a router ID configured for IPv4.

```
R1(config-router-af)# eigrp router-id 1.1.1.1
R1(config-router-af)#
```

c. By default, all IPv6 interfaces are automatically enabled for EIGRP for IPv6. This will be explored further in the next step.

In this scenario, is the **eigrp router-id** command required to configure a router ID for the IPv4 AF? Is it required for the IPv6 AF? What would happen if the router ID was not configured using the **eigrp router-id** command?

En estos escenarios, el comando eigrp router-id no es necesario porque los enrutadores tienen al menos una dirección IPv4 activa. Si no se utiliza el comando eigrp router-id, el enrutador utilizará la dirección de bucle invertido IPv4 más alta. Si no hay direcciones IPv4 loopback, el enrutador utilizará la dirección IPv4 más alta en una interfaz física activa. El ID de enrutador es un valor de 32 bits para EIGRP para IPv4 e IPv6

Step 4: Configure Named EIGRP on R2 and R3.

d. Configure named EIGRP on R2 for the IPv4 address family. The IPv6 unicast routing is enabled in preparation for configuring the IPv6 address family.

```
R2(config)# ipv6 unicast-routing
R2(config)# router eigrp DUAL-STACK
R2(config-router)# address-family ipv4 unicast autonomous-system 4
R2(config-router-af)# eigrp router-id 2.2.2.2
R2(config-router-af)# network 192.168.2.0 0.0.0.3
*Jul 25 20:11:37.643: %DUAL-5-NBRCHANGE: EIGRP-IPv4 4: Neighbor
192.168.2.1 (Serial0/0/0) is up: new adjacency
R2(config-router-af)# network 192.168.3.0
R2(config-router-af)# network 192.168.4.0 0.0.0.3
R2(config-router-af)# exit-address-family
R2(config-router)#
```

Notice that the adjacency between R1 and R2 is established after enabling EIGRP for IPv4 on the serial 0/0/0 interface.

e. Configure the IPv6 address family for EIGRP on R2.

```
R2(config-router)# address-family ipv6 unicast autonomous-system 6
*Jul 25 20:19:05.435: %DUAL-5-NBRCHANGE: EIGRP-IPv6 6: Neighbor
FE80::1 (Serial0/0/0) is up: new adjacency
R2(config-router-af)# eigrp router-id 2.2.2.2
R2(config-router-af)#
```

Notice that the IPv6 adjacency with R1 comes up immediately after configuring the IPv6 AF. This is because by default, all IPv6 interfaces are enabled automatically.

f. On R3, configure named EIGRP on R3 for both the IPv4 and IPv6 address families. After the appropriate commands are configured the IPv4 and IPv6 EIGRP adjacencies are established between R2 and R3. The serial link between R3 and R4 is also automatically enabled in EIGRP for IPv6. This link is not suppose to be included and will be disabled in EIGRP for IPv6 later in step 6.

```
R3(config)# ipv6 unicast-routing
R3(config)# router eigrp DUAL-STACK
R3(config-router)# address-family ipv4 unicast autonomous-system 4
R3(config-router-af)# eigrp router-id 3.3.3.3
R3(config-router-af)# network 192.168.4.0 0.0.0.3
*Jun 26 13:11:41.343: %DUAL-5-NBRCHANGE: EIGRP-IPv4 4: Neighbor
192.168.4.1 (Serial0/0/1) is up: new adjacency
R3(config-router-af)# network 192.168.5.0
R3(config-router-af)# exit-address-family
R3(config-router)# address-family ipv6 unicast autonomous-system 6
*Jun 26 13:12:22.819: %DUAL-5-NBRCHANGE: EIGRP-IPv6 6: Neighbor
FE80::2 (Serial0/0/1) is up: new adjacency
R3(config-router-af)# eigrp router-id 3.3.3.3
R3(config-router-af)#
```

Step 5: Configure passive interfaces for named EIGRP.

g. Within each IPv4 and IPv6 AF is the address family interface configuration mode. This mode is used to configure EIGRP specific parameters on an interface, such as the hello timer and summarization. From address family configuration mode, use the **af-interface** *interface-type interface-number* command to enter address family interface configuration mode. The following output shows the sequence of commands starting from global configuration mode.

```
R1(config)# router eigrp DUAL-STACK
```

```
R1(config-router)# address-family ipv4 unicast autonomous-system 4
R1(config-router-af)# af-interface gigabitethernet 0/0
R1(config-router-af-interface)#
```

h. Issue the **?** to see the commands available in address family interface configuration mode. Notice various commands to configure interface specific parameters such as the hello interval, hold timer, passive interfaces, and summarization.

```
R1(config-router-af-interface)# ?
Address Family Interfaces configuration commands:
  add-paths            Advertise add paths
  authentication       authentication subcommands
  bandwidth-percent    Set percentage of bandwidth percentage limit
  bfd                  Enable Bidirectional Forwarding Detection
  dampening-change     Percent interface metric must change to cause
update
  dampening-interval   Time in seconds to check interface metrics
  default              Set a command to its defaults
  exit-af-interface    Exit from Address Family Interface
configuration mode
  hello-interval       Configures hello interval
  hold-time            Configures hold time
  next-hop-self        Configures EIGRP next-hop-self
  no                   Negate a command or set its defaults
  passive-interface    Suppress address updates on an interface
  shutdown             Disable Address-Family on interface
  split-horizon        Perform split horizon
  summary-address      Perform address summarization

R1(config-router-af-interface)#
```

The interface configuration mode commands are similar for both the IPv4 and IPv6 address families. Commands issued are specific for an interface within the address family, IPv4 or IPv6.

i. Using the **passive-interface** command, configure G0/0 interface as passive for both the IPv4 and IPv6 EIGRP address families.

```
R1(config-router-af-interface)# passive-interface
R1(config-router-af-interface)# exit-af-interface
R1(config-router-af)# exit-address-family
R1(config-router)# address-family ipv6 unicast autonomous-system 6
R1(config-router-af)# af-interface gigabitethernet 0/0
R1(config-router-af-interface)# passive-interface
R1(config-router-af-interface)# exit-af-interface
R1(config-router-af)# exit-address-family
R1(config-router)#
```

j. Configure R2's G0/0 interface as passive for both the IPv4 and IPv6 address families.

```
R2(config)# router eigrp DUAL-STACK
R2(config-router)# address-family ipv4 unicast autonomous-system 4
R2(config-router-af)# af-interface gigabitethernet 0/0
R2(config-router-af-interface)# passive-interface
```

```
R2(config-router-af-interface)# exit-af-interface
R2(config-router-af)# exit-address-family
R2(config-router)# address-family ipv6 unicast autonomous-system 6
R2(config-router-af)# af-interface gigabitethernet 0/0
R2(config-router-af-interface)# passive-interface
R2(config-router-af-interface)# exit
R2(config-router-af)# exit
R2(config-router)#
```

k. Configure R3's G0/0 interface as passive for both the IPv4 and IPv6 address families.

```
R3(config)# router eigrp DUAL-STACK
R3(config-router)# address-family ipv4 unicast autonomous-system 4
R3(config-router-af)# af-interface gigabitethernet 0/0
R3(config-router-af-interface)# passive-interface
R3(config-router-af-interface)# exit-af-interface
R3(config-router-af)# exit-address-family
R3(config-router)# address-family ipv6 unicast autonomous-system 6
R3(config-router-af)# af-interface gigabitethernet 0/0
R3(config-router-af-interface)# passive-interface
R3(config-router-af-interface)# exit
R3(config-router-af)# exit
R3(config-router)#
```

Notice the **exit** command was used as the shorter method for the **exit-af-interface** and **exit-address-family** commands.

Step 6: Disable named EIGRP on a specific IPv6 interface.

l. By default, all IPv6 interfaces are enabled for EIGRP for IPv6. This happens when enabling the IPv6 address family with the **address-family ipv6 unicast autonomous-system** command. Issue the **show ipv6 protocols** command on R3 to verify that all three of its IPv6 interfaces are enabled for EIGRP for IPv6. Notice that the Serial 0/1/0 interface is also included.

```
R3# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "application"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "eigrp 6"
EIGRP-IPv6 VR(DUAL-STACK) Address-Family Protocol for AS(6)
  Metric weight K1=1, K2=0, K3=1, K4=0, K5=0 K6=0
  Metric rib-scale 128
  Metric version 64bit
  NSF-aware route hold timer is 240
  Router-ID: 3.3.3.3
  Topology : 0 (base)
    Active Timer: 3 min
    Distance: internal 90 external 170
    Maximum path: 16
    Maximum hopcount 100
    Maximum metric variance 1
```

```
      Total Prefix Count: 6
      Total Redist Count: 0

    Interfaces:
      Serial0/0/1
      Serial0/1/0
      GigabitEthernet0/0 (passive)
    Redistribution:
      None
R3#
```

m. As shown in the topology, R3's S0/1/0 interface does not need to be included in the EIGRP updates. A default route will be configured later in this lab for reachability beyond the EIGRP routing domain. When we configured the IPv4 AF we excluded the **network** command for this interface. However, the same interface is automatically included when configuring the IPv6 AF. The **shutdown** address family interface command is used to disable EIGRP on a specific interface. This does not disable the physical interface, but only removes it from participating in EIGRP.

```
R3(config)# router eigrp DUAL-STACK
R3(config-router)# address-family ipv6 unicast autonomous-system 6
R3(config-router-af)# af-interface serial 0/1/0
R3(config-router-af-interface)# shutdown
R3(config-router-af-interface)# end
R3#
```

How can you verify that the IPv6 interface is still active, in the "up and up" state?

Hay varias maneras, incluyendo el uso del comando show ipv6 interface brief en R3.

n. Using the **show ipv6 protocols** command, verify that R3 is no longer including S0/1/0 in EIGRP for IPv6.

```
R3# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "application"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "eigrp 6"
EIGRP-IPv6 VR(DUAL-STACK) Address-Family Protocol for AS(6)
  Metric weight K1=1, K2=0, K3=1, K4=0, K5=0 K6=0
  Metric rib-scale 128
  Metric version 64bit
  NSF-aware route hold timer is 240
  Router-ID: 3.3.3.3
  Topology : 0 (base)
    Active Timer: 3 min
    Distance: internal 90 external 170
    Maximum path: 16
    Maximum hopcount 100
    Maximum metric variance 1
    Total Prefix Count: 5
    Total Redist Count: 0
```

```
    Interfaces:
      Serial0/0/1
      GigabitEthernet0/0 (passive)
    Redistribution:
      None
R3#
```

Does the **shutdown** command used on S0/1/0 within the IPv6 AF also have the same affect for that interface within the IPv4 AF?

No, el comando de apagado en S0 / 1/0 se configuró dentro del AF IPv6 y no afecta al IPv4 AF

Step 7: Configure and distribute a default static route in named EIGRP.

bbbb. On R3 configure IPv4 and IPv6 default static routes using an R4 as the next-hop router.

Note: With the use of CEF (Cisco Express Forwarding) it is recommended practice that a next-hop IP address is used instead of an exit-interface. There is a bug in IOS 15.4 that prevents an IPv6 static route with only a next-hop address from being redistributed. A fully specified static route with both an exit-interface and a next-hop address is used in the example.

```
R3(config)# ip route 0.0.0.0 0.0.0.0 192.168.77.1
R3(config)# ipv6 route ::/0 serial0/1/0 2001:db8:feed:77::1
R3(config)#
```

o. Redistribution of static routes in named EIGRP is done in topology configuration mode. Topology configuration mode is a subset of an address family. By default, EIGRP has a base topology for each address family. Additional topologies can be configured for Multitopology Routing (MTR) which is used to enable an EIGRP process for a specified topology. MTR is beyond the scope of CCNP.

For each address family, issue the **topology base** command to enter the base EIGRP topology. In topology configuration mode use the **redistribute static** command to redistribute the default static route into EIGRP.

```
R3(config)# router eigrp DUAL-STACK
R3(config-router)# address-family ipv4 unicast autonomous-system 4
R3(config-router-af)# topology base
R3(config-router-af-topology)# ?
Address Family Topology configuration commands:
  auto-summary           Enable automatic network number summarization
  default                Set a command to its defaults
  default-information    Control distribution of default information
  default-metric         Set metric of redistributed routes
  distance               Define an administrative distance
  distribute-list        Filter entries in eigrp updates
  eigrp                  EIGRP specific commands
  exit-af-topology       Exit from Address Family Topology
configuration mode
  maximum-paths          Forward packets over multiple paths
```

```
  metric                  Modify metrics and parameters for
advertisement
  no                      Negate a command or set its defaults
  offset-list             Add or subtract offset from EIGRP metrics
  redistribute            Redistribute IPv4 routes from another routing
protocol
  snmp                    Modify snmp parameters
  summary-metric          Specify summary to apply metric/filtering
  timers                  Adjust topology specific timers
  traffic-share           How to compute traffic share over alternate
paths
  variance                Control load balancing variance

R3(config-router-af-topology)# redistribute static
R3(config-router-af-topology)# exit-af-topology
R3(config-router-af)# exit-address-family
R3(config-router)# address-family ipv6 unicast autonomous-system 6
R3(config-router-af)# topology base
R3(config-router-af-topology)# redistribute static
R3(config-router-af-topology)# exit-af-topology
R3(config-router-af)# exit-address-family
R3(config-router)#
```

p. Issue the **show ip protocols** and **show ipv6 protocols** commands to verify that EIGRP is redistributing the static route.

```
R3# show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "application"
  Sending updates every 0 seconds
  Invalid after 0 seconds, hold down 0, flushed after 0
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Maximum path: 32
  Routing for Networks:
  Routing Information Sources:
    Gateway         Distance      Last Update
  Distance: (default is 4)

Routing Protocol is "eigrp 4"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks not flagged in outgoing updates
  Default networks not accepted from incoming updates
  Redistributing: static
  EIGRP-IPv4 VR(DUAL-STACK) Address-Family Protocol for AS(4)
    Metric weight K1=1, K2=0, K3=1, K4=0, K5=0 K6=0
    Metric rib-scale 128
    Metric version 64bit
    NSF-aware route hold timer is 240
```

```
    Router-ID: 3.3.3.3
    Topology : 0 (base)
      Active Timer: 3 min
      Distance: internal 90 external 170
      Maximum path: 4
      Maximum hopcount 100
      Maximum metric variance 1
      Total Prefix Count: 5
      Total Redist Count: 1

  Automatic Summarization: disabled
  Maximum path: 4
  Routing for Networks:
    192.168.4.0/30
    192.168.5.0
  Passive Interface(s):
    GigabitEthernet0/0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.4.1           90      02:07:02
  Distance: internal 90 external 170

R3# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "application"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "eigrp 6"
EIGRP-IPv6 VR(DUAL-STACK) Address-Family Protocol for AS(6)
  Metric weight K1=1, K2=0, K3=1, K4=0, K5=0 K6=0
  Metric rib-scale 128
  Metric version 64bit
  NSF-aware route hold timer is 240
  Router-ID: 3.3.3.3
  Topology : 0 (base)
    Active Timer: 3 min
    Distance: internal 90 external 170
    Maximum path: 16
    Maximum hopcount 100
    Maximum metric variance 1
    Total Prefix Count: 6
    Total Redist Count: 1

  Interfaces:
    Serial0/0/1
    GigabitEthernet0/0 (passive)
  Redistribution:
    Redistributing protocol static
IPv6 Routing Protocol is "static"
```

```
R3#
```

Why does the **show ip protocols** command indicate that automatic summarization is disabled? En IOS 15, el resumen automático en EIGRP para IPv4 está desactivado de forma predeterminada. Se puede habilitar mediante el comando auto-summary en el modo de configuración de topología

q. Examine the IPv4 and IPv6 routing tables on R1 to verify that it is receiving the default static route using EIGRP.

```
R1# show ip route eigrp
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.2.2 to network 0.0.0.0

D*EX  0.0.0.0/0 [170/34036062] via 192.168.2.2, 00:03:23, Serial0/0/0
      192.168.4.0/30 is subnetted, 1 subnets
D        192.168.4.0 [90/23796062] via 192.168.2.2, 01:28:22,
Serial0/0/0
D     192.168.5.0/24 [90/23847262] via 192.168.2.2, 01:28:15,
Serial0/0/0
R1# show ipv6 route eigrp
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D -
EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF
ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
EX  ::/0 [170/34036062]
     via FE80::2, Serial0/0/0
D   2001:DB8:CAFE:4::/64 [90/23796062]
     via FE80::2, Serial0/0/0
D   2001:DB8:CAFE:5::/64 [90/23847262]
```

```
     via FE80::2, Serial0/0/0
D   2001:DB8:CAFE:99::/64 [90/23796702]
     via FE80::2, Serial0/0/0
R1#
```

Step 8: Verify named EIGRP.

r. Although named EIGRP unifies configuration for EIGRP for IPv4 and IPv6, the neighbor tables, topology tables and EIGRP routing processes are still separate. Use the **show ip protocols** and **show ipv6 protocols** command to verify both EIGRP for IPv4 and IPv6 processes. Below is the output displayed for R2.

```
R2# show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "application"
  Sending updates every 0 seconds
  Invalid after 0 seconds, hold down 0, flushed after 0
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Maximum path: 32
  Routing for Networks:
  Routing Information Sources:
    Gateway         Distance      Last Update
  Distance: (default is 4)

Routing Protocol is "eigrp 4"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP-IPv4 VR(DUAL-STACK) Address-Family Protocol for AS(4)
    Metric weight K1=1, K2=0, K3=1, K4=0, K5=0 K6=0
    Metric rib-scale 128
    Metric version 64bit
    NSF-aware route hold timer is 240
    Router-ID: 2.2.2.2
    Topology : 0 (base)
      Active Timer: 3 min
      Distance: internal 90 external 170
      Maximum path: 4
      Maximum hopcount 100
      Maximum metric variance 1
      Total Prefix Count: 6
      Total Redist Count: 0

  Automatic Summarization: disabled
  Maximum path: 4
  Routing for Networks:
    192.168.2.0/30
```

```
    192.168.3.0
    192.168.4.0/30
  Passive Interface(s):
    GigabitEthernet0/0
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.2.1           90      00:04:54
    192.168.4.2           90      00:04:54
  Distance: internal 90 external 170

R2#
R2# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "application"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "eigrp 6"
EIGRP-IPv6 VR(DUAL-STACK) Address-Family Protocol for AS(6)
  Metric weight K1=1, K2=0, K3=1, K4=0, K5=0 K6=0
  Metric rib-scale 128
  Metric version 64bit
  NSF-aware route hold timer is 240
  Router-ID: 2.2.2.2
  Topology : 0 (base)
    Active Timer: 3 min
    Distance: internal 90 external 170
    Maximum path: 16
    Maximum hopcount 100
    Maximum metric variance 1
    Total Prefix Count: 6
    Total Redist Count: 0

  Interfaces:
    Serial0/0/0
    Serial0/0/1
    GigabitEthernet0/0 (passive)
  Redistribution:
    None
R2#
```

s. Issue the **show ip eigrp neighbors** and **show ipv6 eigrp neighbors** command on R1 to verify the neighbor adjacencies with R2.

```
R1# show ip eigrp neighbors
EIGRP-IPv4 VR(DUAL-STACK) Address-Family Neighbors for AS(4)
H   Address                 Interface              Hold Uptime    SRTT
RTO  Q  Seq
                                                   (sec)          (ms)
Cnt Num
0   192.168.2.2             Se0/0/0                  13 03:56:20    31
186  0  8
```

```
R1# show ipv6 eigrp neighbors
EIGRP-IPv6 VR(DUAL-STACK) Address-Family Neighbors for AS(6)
H   Address                  Interface              Hold Uptime   SRTT
RTO  Q  Seq
                                                    (sec)         (ms)
Cnt Num
0   Link-local address:      Se0/0/0                  13 00:09:14  669
4014  0  21
    FE80::2
R1#
```

t. Examine R1's EIGRP topology tables for IPv4 and IPv6 using the **show ip eigrp topology** and **show ipv6 eigrp topology** commands.

```
R1# show ip eigrp topology
EIGRP-IPv4 VR(DUAL-STACK) Topology Table for AS(4)/ID(1.1.1.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.2.0/30, 1 successors, FD is 1735175958
        via Connected, Serial0/0/0
P 192.168.1.0/24, 1 successors, FD is 13107200
        via Connected, GigabitEthernet0/0
P 0.0.0.0/0, 1 successors, FD is 4356615958
        via 192.168.2.2 (4356615958/3045895958), Serial0/0/0
P 192.168.4.0/30, 1 successors, FD is 3045895958
        via 192.168.2.2 (3045895958/1735175958), Serial0/0/0
P 192.168.5.0/24, 1 successors, FD is 3052449558
        via 192.168.2.2 (3052449558/1741729558), Serial0/0/0

R1# show ipv6 eigrp topology
EIGRP-IPv6 VR(DUAL-STACK) Topology Table for AS(6)/ID(1.1.1.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 2001:DB8:CAFE:5::/64, 1 successors, FD is 3052449558
        via FE80::2 (3052449558/1741729558), Serial0/0/0
P 2001:DB8:CAFE:4::/64, 1 successors, FD is 3045895958
        via FE80::2 (3045895958/1735175958), Serial0/0/0
P 2001:DB8:CAFE:99::/64, 1 successors, FD is 3045977878
        via FE80::2 (3045977878/1735257878), Serial0/0/0
P 2001:DB8:CAFE:2::/64, 1 successors, FD is 1735175958
        via Connected, Serial0/0/0
P ::/0, 1 successors, FD is 4356615958
        via FE80::2 (4356615958/3045895958), Serial0/0/0
P 2001:DB8:CAFE:1::/64, 1 successors, FD is 13107200
        via Connected, GigabitEthernet0/0

R1#
```

u. Verify that R1 has all the IPv4 and IPv6 routes shown in the topology with the exclusion of R2's LAN by using the **show ip route eigrp** and **show ipv6 route eigrp** commands.

```
R1# show ip route eigrp
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.2.2 to network 0.0.0.0

D*EX  0.0.0.0/0 [170/34036062] via 192.168.2.2, 00:10:25, Serial0/0/0
D     192.168.3.0/24 [90/13607262] via 192.168.2.2, 00:48:46,
Serial0/0/0
      192.168.4.0/30 is subnetted, 1 subnets
D        192.168.4.0 [90/23796062] via 192.168.2.2, 00:48:33,
Serial0/0/0
D     192.168.5.0/24 [90/23847262] via 192.168.2.2, 00:38:12,
Serial0/0/0
R1# show ipv6 route eigrp
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D -
EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF
ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
EX  ::/0 [170/34036062]
     via FE80::2, Serial0/0/0
D   2001:DB8:CAFE:3::/64 [90/13607262]
     via FE80::2, Serial0/0/0
D   2001:DB8:CAFE:4::/64 [90/23796062]
     via FE80::2, Serial0/0/0
D   2001:DB8:CAFE:5::/64 [90/23847262]
     via FE80::2, Serial0/0/0
R1#
```

v. As a final verification of end-to-end reachability, from R1 ping the IPv4 and IPv6 addresses on R5's LAN.

```
R1# ping 192.168.5.1
```

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.5.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/56/56
ms
R1# ping 2001:db8:cafe:5::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DB8:CAFE:5::1, timeout is 2
seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/55/56
ms
R1#
```

w. Examine the named EIGRP configuration showing both the IPv4 and IPv6 address families with the **show running-config | section router eigrp** command. The output for R3 is displayed below.

```
R3# show running-config | section router eigrp
router eigrp DUAL-STACK
 !
 address-family ipv4 unicast autonomous-system 4
  !
  af-interface GigabitEthernet0/0
   passive-interface
  exit-af-interface
  !
  topology base
   redistribute static
  exit-af-topology
  network 192.168.4.0 0.0.0.3
  network 192.168.5.0
  eigrp router-id 3.3.3.3
 exit-address-family
 !
 address-family ipv6 unicast autonomous-system 6
  !
  af-interface GigabitEthernet0/0
   passive-interface
  exit-af-interface
  !
  af-interface Serial0/1/0
   shutdown
  exit-af-interface
  !
  topology base
   redistribute static
  exit-af-topology
  eigrp router-id 3.3.3.3
 exit-address-family
R3#
```

ANEXO LAS PLANTILLAS DE LAS CONFIGURACIONES EN LOS ROUTERS DEL LABORATORIO

Router R1

```
hostname R1
!
ipv6 unicast-routing
ip cef
ipv6 cef
!
interface GigabitEthernet0/0
 ip address 192.168.1.1 255.255.255.0
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:CAFE:1::1/64
!
interface Serial0/0/0
 ip address 192.168.2.1 255.255.255.252
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:CAFE:2::1/64
 clock rate 64000
!
router eigrp DUAL-STACK
 !
 address-family ipv4 unicast autonomous-system 4
  !
  af-interface GigabitEthernet0/0
   passive-interface
  exit-af-interface
  !
  topology base
  exit-af-topology
  network 192.168.1.0
  network 192.168.2.0 0.0.0.3
  eigrp router-id 1.1.1.1
 exit-address-family
 !
 address-family ipv6 unicast autonomous-system 6
  !
  af-interface GigabitEthernet0/0
   passive-interface
  exit-af-interface
  !
  topology base
  exit-af-topology
  eigrp router-id 1.1.1.1
 exit-address-family
!
end
```

Router R2

```
hostname R2
```

```
!
ipv6 unicast-routing
ip cef
ipv6 cef
!
interface GigabitEthernet0/0
 ip address 192.168.3.1 255.255.255.0
 ipv6 address FE80::2 link-local
 ipv6 address 2001:DB8:CAFE:3::1/64
!
interface Serial0/0/0
 ip address 192.168.2.2 255.255.255.252
 ipv6 address FE80::2 link-local
 ipv6 address 2001:DB8:CAFE:2::2/64
!
interface Serial0/0/1
 ip address 192.168.4.1 255.255.255.252
 ipv6 address FE80::2 link-local
 ipv6 address 2001:DB8:CAFE:4::1/64
 clock rate 64000
!
router eigrp DUAL-STACK
 !
 address-family ipv4 unicast autonomous-system 4
  !
  af-interface GigabitEthernet0/0
   passive-interface
  exit-af-interface
  !
  topology base
  exit-af-topology
  network 192.168.2.0 0.0.0.3
  network 192.168.3.0
  network 192.168.4.0 0.0.0.3
  eigrp router-id 2.2.2.2
 exit-address-family
 !
 address-family ipv6 unicast autonomous-system 6
  !
  af-interface GigabitEthernet0/0
   passive-interface
  exit-af-interface
  !
  topology base
  exit-af-topology
  eigrp router-id 2.2.2.2
 exit-address-family
!
end
```

Router R3

```
hostname R3
!
ipv6 unicast-routing
ip cef
ipv6 cef
!
interface GigabitEthernet0/0
 ip address 192.168.5.1 255.255.255.0
```

```
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:CAFE:5::1/64
!
interface Serial0/0/1
 ip address 192.168.4.2 255.255.255.252
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:CAFE:4::2/64
!
interface Serial0/1/0
 ip address 192.168.77.2 255.255.255.0
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:FEED:77::2/64
 clock rate 64000
!
router eigrp DUAL-STACK
 !
 address-family ipv4 unicast autonomous-system 4
  !
  af-interface GigabitEthernet0/0
   passive-interface
  exit-af-interface
  !
  topology base
   redistribute static
  exit-af-topology
  network 192.168.4.0 0.0.0.3
  network 192.168.5.0
  eigrp router-id 3.3.3.3
 exit-address-family
 !
 address-family ipv6 unicast autonomous-system 6
  !
  af-interface GigabitEthernet0/0
   passive-interface
  exit-af-interface
  !
  af-interface Serial0/1/0
   shutdown
  exit-af-interface
  !
  topology base
   redistribute static
  exit-af-topology
  eigrp router-id 3.3.3.3
 exit-address-family
!
ip route 0.0.0.0 0.0.0.0 192.168.77.1
!
ipv6 route ::/0 Serial0/1/0 2001:DB8:FEED:77::1
!
end
```

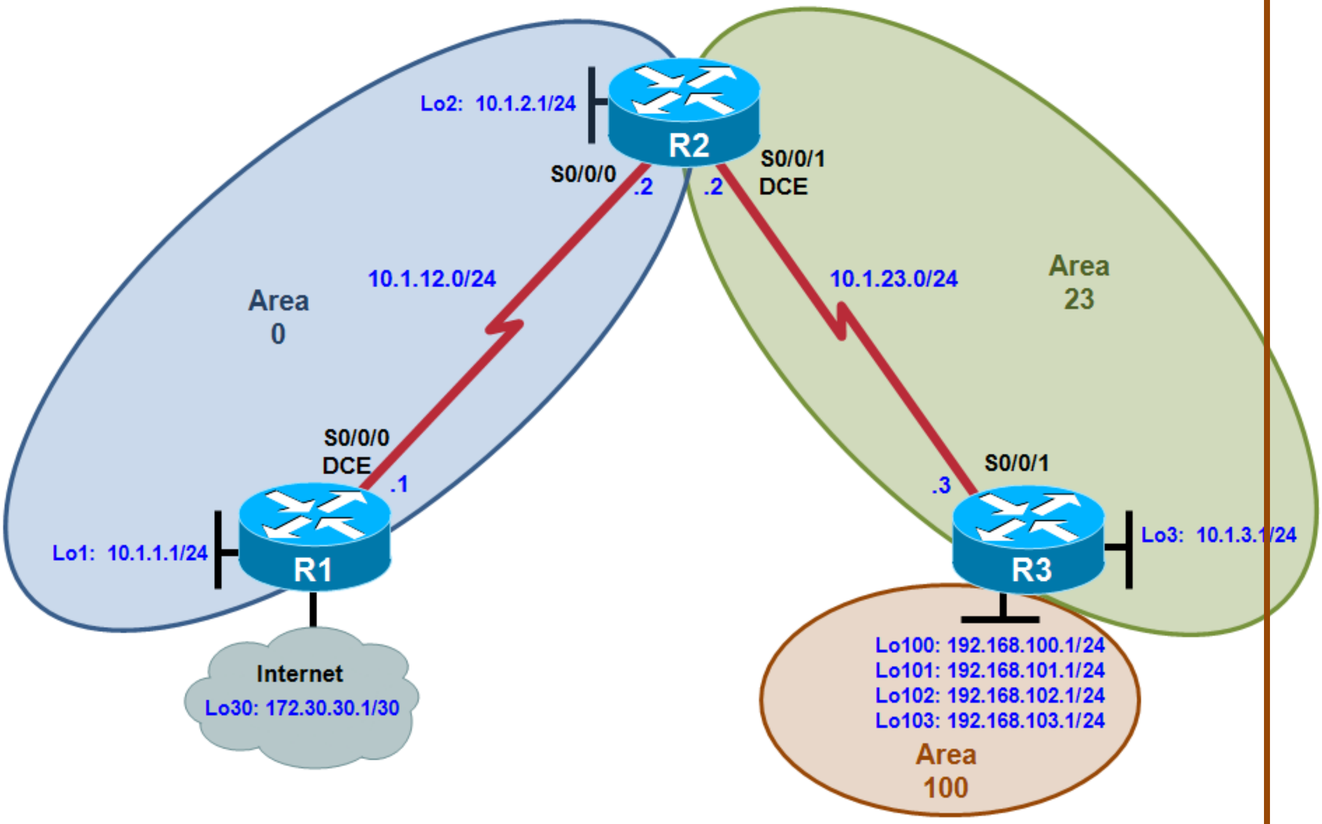
Router R4

```
hostname R4
!
interface Serial0/0/0
 ip address 192.168.77.1 255.255.255.0
 ipv6 address FE80::4 link-local
 ipv6 address 2001:DB8:FEED:77::1/64
!
```

```
ipv6 route 2001:DB8:CAFE::/48 2001:DB8:FEED:77::2
ip route 0.0.0.0 0.0.0.0 192.168.77.2
!
end
```

Chapter 3 Lab 3-1, OSPF Virtual Links

Topology



Objectives

- Configure multi-area OSPF on a router.
- Verify multi-area behavior.
- Create an OSPF virtual link.
- Summarize an area.
- Generate a default route into OSPF.

Background

You are responsible for configuring the new network to connect your company's engineering, marketing, and accounting departments, represented by loopback interfaces on each of the three routers. The physical devices have just been installed and connected by serial cables. Configure multiple-area OSPFv2 to allow full connectivity between all departments.

In addition, R1 has a loopback interface representing a connection to the Internet. This connection will not be added into OSPFv2. R3 will have four additional loopback interfaces representing connections to branch offices.

Note: This lab uses Cisco 1941 routers with Cisco IOS Release 15.4 with IP Base. The switches are Cisco WS-C2960-24TT-L with Fast Ethernet interfaces, therefore the router will use routing metrics associated with a 100 Mb/s interface. Depending on the router or switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 3 routers (Cisco IOS Release 15.2 or comparable)
- Serial and Ethernet cables

Step 0: Suggested starting configurations.

cccc. Apply the following configuration to each router along with the appropriate **hostname**. The **exec-timeout 0 0** command should only be used in a lab environment.

```
Router(config)# no ip domain-lookup
Router(config)# line con 0
Router(config-line)# logging synchronous
Router(config-line)# exec-timeout 0 0
```

Step 1: Configure addressing and loopbacks.

Using the addressing scheme in the diagram, apply IP addresses to the serial interfaces on R1, R2, and R3. Create loopbacks on R1, R2, and R3, and address them according to the diagram.

```
R1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)# interface loopback 1
R1(config-if)# description Engineering Department
R1(config-if)# ip address 10.1.1.1 255.255.255.0
R1(config-if)# interface loopback 30
R1(config-if)# ip address 172.30.30.1 255.255.255.252
R1(config-if)# interface serial 0/0/0
R1(config-if)# ip address 10.1.12.1 255.255.255.0
R1(config-if)# clockrate 64000
R1(config-if)# no shutdown

R2# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R2(config)# interface loopback 2
R2(config-if)# description Marketing Department
R2(config-if)# ip address 10.1.2.1 255.255.255.0
R2(config-if)# interface serial 0/0/0
R2(config-if)# ip address 10.1.12.2 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)# interface serial 0/0/1
R2(config-if)# ip address 10.1.23.2 255.255.255.0
R2(config-if)# clockrate 64000
R2(config-if)# no shutdown

R3# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)# interface loopback 3
R3(config-if)# description Accounting Department
R3(config-if)# ip address 10.1.3.1 255.255.255.0
R3(config-if)# interface loopback 100
```

```
R3(config-if)# ip address 192.168.100.1 255.255.255.0
R3(config-if)# interface loopback 101
R3(config-if)# ip address 192.168.101.1 255.255.255.0
R3(config-if)# interface loopback 102
R3(config-if)# ip address 192.168.102.1 255.255.255.0
R3(config-if)# interface loopback 103
R3(config-if)# ip address 192.168.103.1 255.255.255.0
R3(config-if)# interface serial 0/0/1
R3(config-if)# ip address 10.1.23.3 255.255.255.0
R3(config-if)# no shutdown
```

Step 2: Add interfaces into OSPF.

dddd. Create OSPF process 1 and OSPF router ID on all three routers. Using the **network** command, configure the subnet of the serial link between R1 and R2 to be in OSPF area 0. Add loopback 1 on R1 and loopback 2 on R2 into OSPF area 0.

Note: The default behavior of OSPF for loopback interfaces is to advertise a 32-bit host route. To ensure that the full /24 network is advertised, use the **ip ospf network point-to-point** command. Change the network type on the loopback interfaces so that they are advertised with the correct subnet.

```
R1(config)# router ospf 1
R1(config-router)# router-id 1.1.1.1
R1(config-router)# network 10.1.12.0 0.0.0.255 area 0
R1(config-router)# network 10.1.1.0 0.0.0.255 area 0
R1(config-router)# exit
R1(config)# interface loopback 1
R1(config-if)# ip ospf network point-to-point
R1(config-if)# end
```

The **show ip ospf** command should be used to verify the OSPF router ID. If the OSPF router ID is using a 32-bit value other than the one specified by the **router-id** command, you can reset the router ID by using the **clear ip ospf** *pid* **process** command and re-verify using the command **show ip ospf**.

```
R1# show ip ospf
 Routing Process "ospf 1" with ID 172.30.30.1
 Start time: 04:19:23.024, Time elapsed: 00:31:01.416
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Supports NSSA (compatible with RFC 3101)
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
```

```
R1# clear ip ospf 1 process
Reset OSPF process 1? [no]: yes
R1# show ip ospf
 Routing Process "ospf 1" with ID 1.1.1.1
 Start time: 04:19:23.024, Time elapsed: 00:31:01.416
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Supports NSSA (compatible with RFC 3101)
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa

R1#

R2(config)# router ospf 1
R2(config-router)# router-id 2.2.2.2
R2(config-router)# network 10.1.12.0 0.0.0.255 area 0
R2(config-router)# network 10.1.2.0 0.0.0.255 area 0
R2(config-router)# exit
R2(config)# interface loopback 2
R2(config-if)# ip ospf network point-to-point
R2(config-if)# end
```

Again, the **show ip ospf** command should be used to verify the OSPF router ID. If the OSPF router ID is using a 32-bit value other than the one specified by the **router-id** command, you can reset the router ID by using the **clear ip ospf** *pid* **process** command and re-verify using the command **show ip ospf**.

eeee. Verify that you can see OSPF neighbors in the **show ip ospf neighbors** output on both routers. Verify that the routers can see each other's loopback with the **show ip route** command.

```
R1# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
2.2.2.2           0   FULL/  -        00:00:30    10.1.12.2
Serial0/0/0

R1# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
```

```
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C        10.1.1.0/24 is directly connected, Loopback1
L        10.1.1.1/32 is directly connected, Loopback1
O        10.1.2.0/24 [110/65] via 10.1.12.2, 00:05:04, Serial0/0/0
C        10.1.12.0/24 is directly connected, Serial0/0/0
L        10.1.12.1/32 is directly connected, Serial0/0/0
      172.30.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.30.30.0/30 is directly connected, Loopback30
L        172.30.30.1/32 is directly connected, Loopback30
R1#

R2# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
1.1.1.1           0   FULL/  -        00:00:30    10.1.12.1
Serial0/0/0

R2# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O        10.1.1.0/24 [110/65] via 10.1.12.1, 00:06:33, Serial0/0/0
C        10.1.2.0/24 is directly connected, Loopback2
L        10.1.2.1/32 is directly connected, Loopback2
C        10.1.12.0/24 is directly connected, Serial0/0/0
L        10.1.12.2/32 is directly connected, Serial0/0/0
C        10.1.23.0/24 is directly connected, Serial0/0/1
L        10.1.23.2/32 is directly connected, Serial0/0/1
R2#
```

ffff. Add the subnet between R2 and R3 into OSPF area 23 using the **network** command. Add loopback 3 on R3 into area 23.

```
R2(config)# router ospf 1
```

```
R2(config-router)# network 10.1.23.0 0.0.0.255 area 23

R3(config)# router ospf 1
R3(config-router)# router-id 3.3.3.3
R3(config-router)# network 10.1.23.0 0.0.0.255 area 23
R3(config-router)# network 10.1.3.0 0.0.0.255 area 23
R3(config-router)# exit
R3(config)# interface loopback 3
R3(config-if)# ip ospf network point-to-point
```

Again, the **show ip ospf** command should used to verify the OSPF router ID. If the OSPF router ID is using a 32-bit value other than the one specified by the **router-id** command, you can reset the router ID by using the **clear ip ospf** *pid* **process** command and re-verify using the command **show ip ospf**.

gggg. Verify that this neighbor relationship comes up with the **show ip ospf neighbors** command.

```
R2# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
1.1.1.1           0   FULL/  -        00:00:35    10.1.12.1
Serial0/0/0
3.3.3.3           0   FULL/  -        00:00:33    10.1.23.3
Serial0/0/1
R2#
```

Step 3: Create a virtual link.

hhhh. Add loopbacks 100 through 103 on R3 to R3's OSPF process in area 100 using the **network** command. Change the network type to advertise the correct subnet mask.

```
R3(config)# router ospf 1
R3(config-router)# network 192.168.100.0 0.0.3.255 area 100
R3(config-router)# exit
R3(config)# interface loopback 100
R3(config-if)# ip ospf network point-to-point
R3(config-if)# interface loopback 101
R3(config-if)# ip ospf network point-to-point
R3(config-if)# interface loopback 102
R3(config-if)# ip ospf network point-to-point
R3(config-if)# interface loopback 103
R3(config-if)# ip ospf network point-to-point
```

iiii. Look at the output of the **show ip route** command on R2. Notice that the routes to those networks do not appear. The reason for this behavior is that area 100 on R3 is not connected to the backbone. It is only connected to area 23. If an area is not connected to the backbone, its routes are not advertised outside of its area.

```
R2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
```

```
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
O        10.1.1.0/24 [110/65] via 10.1.12.1, 00:09:22, Serial0/0/0
C        10.1.2.0/24 is directly connected, Loopback2
L        10.1.2.1/32 is directly connected, Loopback2
O        10.1.3.0/24 [110/65] via 10.1.23.3, 00:08:03, Serial0/0/1
C        10.1.12.0/24 is directly connected, Serial0/0/0
L        10.1.12.2/32 is directly connected, Serial0/0/0
C        10.1.23.0/24 is directly connected, Serial0/0/1
L        10.1.23.2/32 is directly connected, Serial0/0/1
R2#
```

What would happen if routes could pass between areas without going through the backbone?

Los bucles de enrutamiento pueden ocurrir porque cualquier ruta podría publicitarse en diferentes áreas. Al pasar a través del backbone, 3 tipos de LSAs son generados por sus respectivas áreas y no devueltos.

You can get around this situation by creating a virtual link. A virtual link is an OSPF feature that creates a logical extension of the backbone area across a regular area, without actually adding any physical interfaces into area 0.

Note: Prior to creating a virtual link you need to identify the OSPF router ID for the routers involved (R2 and R3), using a command such as **show ip ospf**, **show ip protocols** or **show ip ospf interface**. The output for the **show ip ospf** command on R1 and R3 is shown below.

```
R2# show ip ospf
 Routing Process "ospf 1" with ID 2.2.2.2
<output omitted>

R3# show ip ospf
 Routing Process "ospf 1" with ID 3.3.3.3
<output omitted>
```

jjjj. Create a virtual link using the **area** *transit_area* **virtual-link** *router-id* OSPF configuration command on both R2 and R3.

```
R2(config)# router ospf 1
R2(config-router)# area 23 virtual-link 3.3.3.3
R2(config-router)#

R3(config)# router ospf 1
R3(config-router)# area 23 virtual-link 2.2.2.2
*Aug  9 12:47:46.110: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on
OSPF_VL0 from LOADING to FULL, Loading Done
R3(config-router)#
```

Notice after virtual links are established IOS will report full adjacency between both routers.

kkkk. After you see the adjacency over the virtual interface come up, issue the **show ip route** command on R2 and see the routes from area 100. You can verify the virtual link with the **show ip ospf neighbor** and **show ip ospf interface** commands.

```
R2# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
O        10.1.1.0/24 [110/65] via 10.1.12.1, 00:18:16, Serial0/0/0
C        10.1.2.0/24 is directly connected, Loopback2
L        10.1.2.1/32 is directly connected, Loopback2
O        10.1.3.0/24 [110/65] via 10.1.23.3, 00:16:57, Serial0/0/1
C        10.1.12.0/24 is directly connected, Serial0/0/0
L        10.1.12.2/32 is directly connected, Serial0/0/0
C        10.1.23.0/24 is directly connected, Serial0/0/1
L        10.1.23.2/32 is directly connected, Serial0/0/1
O IA  192.168.100.0/24 [110/65] via 10.1.23.3, 00:03:28, Serial0/0/1
O IA  192.168.101.0/24 [110/65] via 10.1.23.3, 00:03:28, Serial0/0/1
O IA  192.168.102.0/24 [110/65] via 10.1.23.3, 00:03:28, Serial0/0/1
O IA  192.168.103.0/24 [110/65] via 10.1.23.3, 00:03:28, Serial0/0/1
R2#

R2# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address
Interface
3.3.3.3           0   FULL/  -            -        10.1.23.3
OSPF_VL0
1.1.1.1           0   FULL/  -        00:00:38    10.1.12.1
Serial0/0/0
3.3.3.3           0   FULL/  -        00:00:35    10.1.23.3
Serial0/0/1

R2# show ip ospf interface
OSPF_VL0 is up, line protocol is up
  Internet Address 10.1.23.2/24, Area 0, Attached via Not Attached
  Process ID 1, Router ID 2.2.2.2, Network Type VIRTUAL_LINK, Cost:
64
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           64        no          no            Base
  Configured as demand circuit
  Run as demand circuit
  DoNotAge LSA allowed
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit
5
    oob-resync timeout 40
    Hello due in 00:00:02
```

```
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 3/4, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 3.3.3.3  (Hello suppressed)
  Suppress hello for 1 neighbor(s)
<output omitted>
```

When are virtual links useful?

Los enlaces virtuales son útiles cuando debe existir una extensión temporal del Backbone, ya sea porque el Backbone se ha vuelto discontinuado o se ha agregado una nueva área a un área existente.

Why are virtual links a poor long-term solution?

Los enlaces virtuales son una pobre solución a largo plazo porque agregan la sobrecarga de procesamiento y, básicamente, extienden el área del Backbone a los routers en los que tal vez no pertenezca. También pueden agregar mucha complejidad a la solución de problemas.

Step 4: Summarize an area.

Loopbacks 100 through 103 can be summarized into one supernet of 192.168.100.0 /22. You can configure area 100 to be represented by this single summary route.

llll. Configure R3 (the ABR) to summarize this area using the **area** *area* **range** *network mask* command.

```
R3(config)# router ospf 1
R3(config-router)# area 100 range 192.168.100.0 255.255.252.0
```

mmmm. You can see the summary route on R2 with the **show ip route** and **show ip ospf database** commands.

```
R2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
O        10.1.1.0/24 [110/65] via 10.1.12.1, 00:24:14, Serial0/0/0
C        10.1.2.0/24 is directly connected, Loopback2
L        10.1.2.1/32 is directly connected, Loopback2
O        10.1.3.0/24 [110/65] via 10.1.23.3, 00:22:55, Serial0/0/1
C        10.1.12.0/24 is directly connected, Serial0/0/0
```

```
L        10.1.12.2/32 is directly connected, Serial0/0/0
C        10.1.23.0/24 is directly connected, Serial0/0/1
L        10.1.23.2/32 is directly connected, Serial0/0/1
O IA  192.168.100.0/22 [110/65] via 10.1.23.3, 00:00:04, Serial0/0/1
R2#

R2# show ip ospf database

            OSPF Router with ID (2.2.2.2) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link
count
1.1.1.1         1.1.1.1         98          0x80000006 0x00AA98 3
2.2.2.2         2.2.2.2         608         0x80000006 0x00AF0B 4
3.3.3.3         3.3.3.3         1      (DNA) 0x80000002 0x00ADFC 1

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.3.0        2.2.2.2         1408        0x80000001 0x002ABB
10.1.3.0        3.3.3.3         1      (DNA) 0x80000002 0x008799
10.1.23.0       2.2.2.2         1482        0x80000001 0x00438F
10.1.23.0       3.3.3.3         1      (DNA) 0x80000002 0x0023AA
192.168.100.0   3.3.3.3         1      (DNA) 0x80000003 0x00243F

                Router Link States (Area 23)

Link ID         ADV Router      Age         Seq#       Checksum Link
count
2.2.2.2         2.2.2.2         608         0x80000003 0x0099A1 2
3.3.3.3         3.3.3.3         609         0x80000005 0x00E92B 3

                Summary Net Link States (Area 23)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.1.0        2.2.2.2         1482        0x80000002 0x003EA8
10.1.2.0        2.2.2.2         1482        0x80000002 0x00B075
10.1.12.0       2.2.2.2         1482        0x80000002 0x00BA22
192.168.100.0   3.3.3.3         43          0x80000002 0x00263E
R2#
```

nnnn. Notice on R3 that OSPF has generated a summary route pointing toward Null0.

```
R3#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set
```

```
        10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O          10.1.1.0/24 [110/129] via 10.1.23.2, 00:02:17, Serial0/0/1
O          10.1.2.0/24 [110/65] via 10.1.23.2, 00:02:17, Serial0/0/1
C          10.1.3.0/24 is directly connected, Loopback3
L          10.1.3.1/32 is directly connected, Loopback3
O          10.1.12.0/24 [110/128] via 10.1.23.2, 00:02:17, Serial0/0/1
C          10.1.23.0/24 is directly connected, Serial0/0/1
L          10.1.23.3/32 is directly connected, Serial0/0/1
O       192.168.100.0/22 is a summary, 00:02:17, Null0
        192.168.100.0/24 is variably subnetted, 2 subnets, 2 masks
C          192.168.100.0/24 is directly connected, Loopback100
L          192.168.100.1/32 is directly connected, Loopback100
        192.168.101.0/24 is variably subnetted, 2 subnets, 2 masks
C          192.168.101.0/24 is directly connected, Loopback101
L          192.168.101.1/32 is directly connected, Loopback101
        192.168.102.0/24 is variably subnetted, 2 subnets, 2 masks
C          192.168.102.0/24 is directly connected, Loopback102
L          192.168.102.1/32 is directly connected, Loopback102
        192.168.103.0/24 is variably subnetted, 2 subnets, 2 masks
C          192.168.103.0/24 is directly connected, Loopback103
L          192.168.103.1/32 is directly connected, Loopback103
R3#
```

This behavior is known as sending unknown traffic to the "bit bucket." This means that if the router advertising the summary route receives a packet destined for something covered by that summary but not in the routing table, it drops it.

What is the reasoning behind this behavior?

La razón por la que los resúmenes generan rutas locales a Null0 es que cuando un enrutador crea una dirección de resumen, debe tener rutas a todas las rutas existentes más específicas. Si el enrutador carece de una ruta más específica para un prefijo dentro del resumen, se supone que la ruta no existe, y los paquetes destinados a ese prefijo deben ser eliminados. Si la ruta no existiera, el ancho de banda podría ser desperdiciado si este enrutador tiene una ruta menos específica (como una ruta predeterminada) y reenvía el paquete a la ruta hasta que se cae más abajo en la línea.

La ruta de descarte también resuelve otro problema. Dependiendo del contenido de la tabla de enrutamiento, puede formarse un bucle de enrutamiento entre dos routers, uno recibiendo una ruta de resumen desde el segundo, mientras que el segundo utiliza el primero como su puerta de enlace predeterminada. Si se recibió un paquete para un componente no existente de la ruta de resumen y no hubo ruta de descarte instalada en el segundo enrutador, el paquete se enlazaría entre los routers hasta que su TTL se redujera a 0.

Step 5: Generate a default route into OSPF.

You can simulate loopback 30 on R1 to be a connection to the Internet. You do not need to advertise this specific network to the rest of the network. Instead, you can just have a default route for all unknown traffic to go to R1.

oooo. To have R1 generate a default route, use the OSPF configuration command **default-information originate always**. The **always** keyword is necessary for generating a default route in this scenario. Without this keyword, a default route is generated only into OSPF if one exists in the routing table.

```
R1(config)# router ospf 1
R1(config-router)# default-information originate always
```

pppp. Verify that the default route appears on R2 and R3 with the **show ip route** command.

```
R2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 10.1.12.1 to network 0.0.0.0

O*E2  0.0.0.0/0 [110/1] via 10.1.12.1, 00:00:13, Serial0/0/0
      10.0.0.0/8 is variably subnetted, 8 subnets, 2 masks
O        10.1.1.0/24 [110/65] via 10.1.12.1, 00:28:42, Serial0/0/0
C        10.1.2.0/24 is directly connected, Loopback2
L        10.1.2.1/32 is directly connected, Loopback2
O        10.1.3.0/24 [110/65] via 10.1.23.3, 00:27:23, Serial0/0/1
C        10.1.12.0/24 is directly connected, Serial0/0/0
L        10.1.12.2/32 is directly connected, Serial0/0/0
C        10.1.23.0/24 is directly connected, Serial0/0/1
L        10.1.23.2/32 is directly connected, Serial0/0/1
O IA  192.168.100.0/22 [110/65] via 10.1.23.3, 00:04:32, Serial0/0/1
R2#

R3#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 10.1.23.2 to network 0.0.0.0

O*E2  0.0.0.0/0 [110/1] via 10.1.23.2, 00:00:45, Serial0/0/1
      10.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O        10.1.1.0/24 [110/129] via 10.1.23.2, 00:05:08, Serial0/0/1
O        10.1.2.0/24 [110/65] via 10.1.23.2, 00:05:08, Serial0/0/1
C        10.1.3.0/24 is directly connected, Loopback3
L        10.1.3.1/32 is directly connected, Loopback3
O        10.1.12.0/24 [110/128] via 10.1.23.2, 00:05:08, Serial0/0/1
C        10.1.23.0/24 is directly connected, Serial0/0/1
L        10.1.23.3/32 is directly connected, Serial0/0/1
O     192.168.100.0/22 is a summary, 00:05:08, Null0
      192.168.100.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.100.0/24 is directly connected, Loopback100
L        192.168.100.1/32 is directly connected, Loopback100
      192.168.101.0/24 is variably subnetted, 2 subnets, 2 masks
```

```
C        192.168.101.0/24 is directly connected, Loopback101
L        192.168.101.1/32 is directly connected, Loopback101
      192.168.102.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.102.0/24 is directly connected, Loopback102
L        192.168.102.1/32 is directly connected, Loopback102
      192.168.103.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.103.0/24 is directly connected, Loopback103
L        192.168.103.1/32 is directly connected, Loopback103
R3#
```

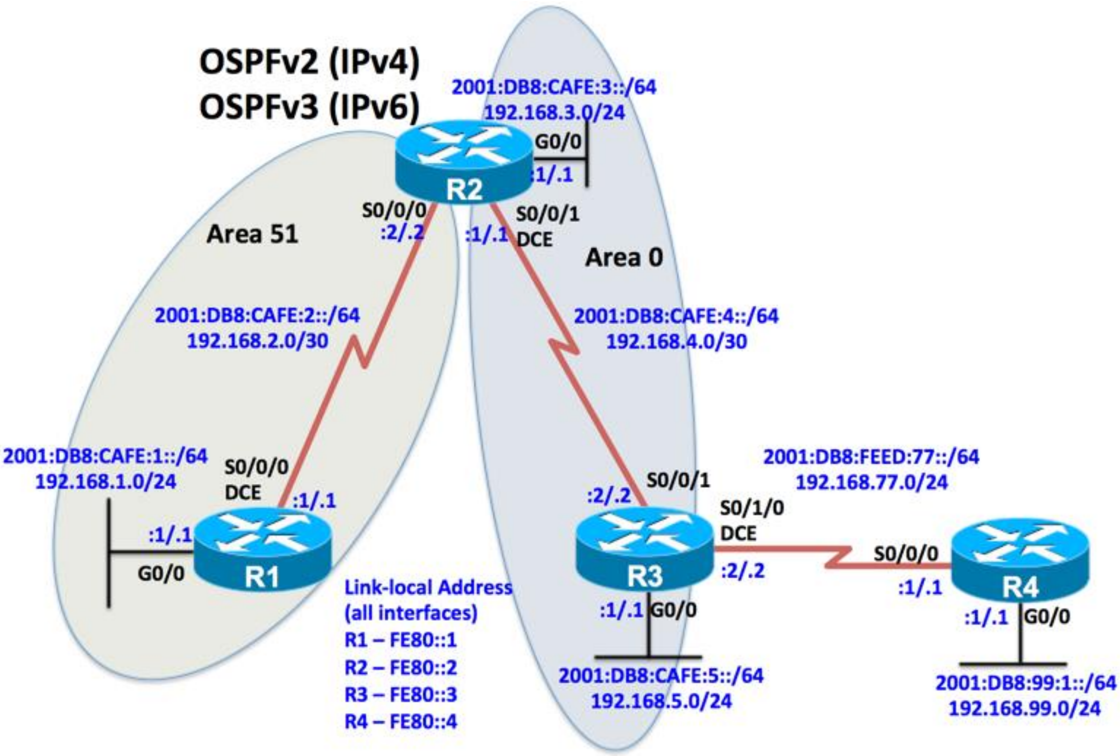
qqqq. You should be able to ping the interface connecting to the Internet from R2 or R3, despite never being advertised into OSPF.

```
R3# ping 172.30.30.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.30.30.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/30/32
ms
```

Chapter 3 Lab 3-2, Multi-Area OSPFv2 and OSPFv3 with Stub Area

Topology



Objectives

- Configure multi-area OSPFv2 for IPv4.

- Configure multi-area OSPFv3 for IPv6
- Verify multi-area behavior.
- Configure stub and totally stubby areas for OSPFv2.
- Configure stub and totally stubby areas for OSPFv3.

Background

In this lab, you will configure the network with multi-area OSPFv2 routing for IPv4 and multi-area OSPFv3 routing for IPv6. For both OSPFv2 and OSPFv3, area 51 will be configured as a normal OSPF area, a stub area and then a totally stubby area.

Note: This lab uses Cisco 1941 routers with Cisco IOS Release 15.4 with IP Base. The switches are Cisco WS-C2960-24TT-L with Fast Ethernet interfaces, therefore the router will use routing metrics associated with a 100 Mb/s interface. Depending on the router or switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 4 routers (Cisco IOS Release 15.2 or comparable)
- 4 switches (LAN interfaces)
- Serial and Ethernet cables

Step 0: Suggested starting configurations.

rrrr. Apply the following configuration to each router along with the appropriate **hostname**. The **exec-timeout 0 0** command should only be used in a lab environment.

```
Router(config)# no ip domain-lookup
Router(config)# line con 0
Router(config-line)# logging synchronous
Router(config-line)# exec-timeout 0 0
```

Step 1: Configure the addressing and serial links.

ssss. Using the topology, configure the IPv4 and IPv6 addresses on the interfaces of each router.

```
R1(config)# interface GigabitEthernet0/0
R1(config-if)# ip address 192.168.1.1 255.255.255.0
R1(config-if)# ipv6 address FE80::1 link-local
R1(config-if)# ipv6 address 2001:DB8:CAFE:1::1/64
R1(config-if)# no shutdown
R1(config-if)# exit
R1(config)# interface Serial0/0/0
R1(config-if)# ip address 192.168.2.1 255.255.255.252
R1(config-if)# ipv6 address FE80::1 link-local
R1(config-if)# ipv6 address 2001:DB8:CAFE:2::1/64
R1(config-if)# clock rate 64000
R1(config-if)# no shutdown

R2(config)# interface GigabitEthernet0/0
R2(config-if)# ip address 192.168.3.1 255.255.255.0
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:3::1/64
```

```
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Serial0/0/0
R2(config-if)# ip address 192.168.2.2 255.255.255.252
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:2::2/64
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Serial0/0/1
R2(config-if)# ip address 192.168.4.1 255.255.255.252
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:4::1/64
R2(config-if)# clock rate 64000
R2(config-if)# no shutdown

R3(config)# interface GigabitEthernet0/0
R3(config-if)# ip address 192.168.5.1 255.255.255.0
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:CAFE:5::1/64
R3(config-if)# no shutdown
R3(config-if)# exit
R3(config)# interface Serial0/0/1
R3(config-if)# ip address 192.168.4.2 255.255.255.252
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:CAFE:4::2/64
R3(config-if)# no shutdown
R3(config-if)# exit
R3(config)# interface Serial0/1/0
R3(config-if)# ip address 192.168.77.2 255.255.255.0
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:FEED:77::2/64
R3(config-if)# clock rate 64000
R3(config-if)# no shutdown
R3(config-if)#

R4(config)# interface Serial0/0/0
R4(config-if)# ip address 192.168.77.1 255.255.255.0
R4(config-if)# ipv6 address FE80::4 link-local
R4(config-if)# ipv6 address 2001:DB8:FEED:77::1/64
R4(config-if)# no shutdown
R4(config-if)# exit
R4(config)# interface gigabitethernet 0/0
R4(config-if)# ip address 192.168.99.1 255.255.255.0
R4(config-if)# ipv6 address 2001:db8:99:1::1/64
R4(config-if)# no shutdown
R4(config-if)# exit
R4(config)# ipv6 unicast-routing
R4(config)# ipv6 route 2001:DB8:CAFE::/48 2001:DB8:FEED:77::2
```

```
R4(config)# ip route 0.0.0.0 0.0.0.0 192.168.77.2
R4(config)#
```

tttt. Verify connectivity by pinging across each of the local networks connected to each router.

uuuu. Issue the **show ip interface brief** and the **show ipv6 interface brief** command on each router. These commands display a brief listing of the interfaces, their status, and their IP addresses. Router R1 is shown as an example.

```
R1# show ip interface brief
Interface                  IP-Address      OK? Method Status
Protocol
Embedded-Service-Engine0/0 unassigned      YES unset
administratively down down
GigabitEthernet0/0         192.168.1.1     YES manual up
up
GigabitEthernet0/1         unassigned      YES unset
administratively down down
Serial0/0/0                192.168.2.1     YES manual up
up
Serial0/0/1                unassigned      YES unset
administratively down down
R1# show ipv6 interface brief
Em0/0                  [administratively down/down]
    unassigned
GigabitEthernet0/0     [up/up]
    FE80::1
    2001:DB8:CAFE:1::1
GigabitEthernet0/1     [administratively down/down]
    unassigned
Serial0/0/0            [up/up]
    FE80::1
    2001:DB8:CAFE:2::1
Serial0/0/1            [administratively down/down]
    unassigned
R1#
```

Step 2: Configure multi-area OSPFv2.

Create OSPFv2 process 1 on routers R1, R2 and R3. Configure the OSPF router ID on each router. Enable directly connected networks into the OSPF process using the **ip ospf** *process-id* **area** *area-id* interface command that is available with Cisco IOS version 12.3(11)T and later.

Note: The **show ip ospf** command should used to verify the OSPF router ID. If the OSPF router ID is using a 32-bit value other than the one specified by the **router-id** command, you can reset the router ID by using the **clear ip ospf** *pid* **process** command and re-verify using the command **show ip ospf**.

x. Configure R3 as an OSPFv2 router in area 0.

```
R3(config)# router ospf 1
R3(config-router)# router-id 3.3.3.3
R3(config-router)# exit
R3(config)# interface gigabitethernet 0/0
R3(config-if)# ip ospf 1 area 0
R3(config-if)# exit
R3(config)# interface serial 0/0/1
R3(config-if)# ip ospf 1 area 0
```

```
R3(config-if)#
```

Note: Another option is to use the OSPF **network** command in router configuration mode.

y. Configure R2 as an ABR router for area 0 and area 51. Interfaces S0/0/1 and G0/0 are in area 0, while interface S0/0/0 is in area 51.

```
R2(config)# router ospf 1
R2(config-router)# router-id 2.2.2.2
R2(config-router)# exit
R2(config)# interface serial 0/0/1
R2(config-if)# ip ospf 1 area 0
R2(config-if)# exit
R2(config)# interface gigabitethernet 0/0
R2(config-if)# ip ospf 1 area 0
R2(config-if)# exit
R2(config)# interface serial 0/0/0
R2(config-if)# ip ospf 1 area 51
R2(config-if)#
```

What address on R2 is used to form the neighbor adjacency with R1? What type of IPv6 address is used to establish the adjacencies?

La direccion utilizada para hallar ayacencias es FE80::2 la interfaz del router vecino y se configure manual mente por el primer paso.____

z. Configure R1 as an internal OSPFv2 router in area 51.

```
R1(config)# router ospf 1
R1(config-router)# router-id 1.1.1.1
R1(config-router)# exit
R1(config)# interface serial 0/0/0
R1(config-if)# ip ospf 1 area 51
R1(config-if)# exit
R1(config)# interface gigabitethernet 0/0
R1(config-if)# ip ospf 1 area 51
R1(config-if)#
```

aa. Verify that the routers have OSPFv2 neighbors using the **show ip ospf neighbors** command. The output for R2 is displayed.

```
R2# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
3.3.3.3           0   FULL/  -        00:00:36    192.168.4.2
Serial0/0/1
1.1.1.1           0   FULL/  -        00:00:32    192.168.2.1
Serial0/0/0
R2#
```

vvvv. Verify that router R3 can see all the IPv4 networks in the OSPFv2 routing domain using the **show ip route** command.

```
R3# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

O IA  192.168.1.0/24 [110/129] via 192.168.4.1, 00:14:43, Serial0/0/1
      192.168.2.0/30 is subnetted, 1 subnets
O IA     192.168.2.0 [110/128] via 192.168.4.1, 00:20:16, Serial0/0/1
O     192.168.3.0/24 [110/65] via 192.168.4.1, 00:26:25, Serial0/0/1
      192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.4.0/30 is directly connected, Serial0/0/1
L        192.168.4.2/32 is directly connected, Serial0/0/1
      192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.5.0/24 is directly connected, GigabitEthernet0/0
L        192.168.5.1/32 is directly connected, GigabitEthernet0/0
      192.168.77.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.77.0/24 is directly connected, Serial0/1/0
L        192.168.77.2/32 is directly connected, Serial0/1/0
R3#
```

How many OSPFv2 intra-area routes area routes are in R3's IPv4 routing table? How many inter-area routes are in R3's IPv4 routing table?

en el presente se encuentras 2 rutas de intra-area estabecidad en las dos listas de erutamiento____________

wwww. Issue the **show ip route** command on R2.

```
R2# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

O     192.168.1.0/24 [110/65] via 192.168.2.1, 00:22:38, Serial0/0/0
      192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
```

```
C        192.168.2.0/30 is directly connected, Serial0/0/0
L        192.168.2.2/32 is directly connected, Serial0/0/0
      192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.3.0/24 is directly connected, GigabitEthernet0/0
L        192.168.3.1/32 is directly connected, GigabitEthernet0/0
      192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.4.0/30 is directly connected, Serial0/0/1
L        192.168.4.1/32 is directly connected, Serial0/0/1
O     192.168.5.0/24 [110/65] via 192.168.4.2, 00:28:17, Serial0/0/1
R2#
```

Why doesn't R2 have any inter-area OSPFv2 routes in its routing table?

es considerada un ABR, y presenta interfaces en las areas 51 y 0, estas redes son consideradas ospfv2-intra

____

____

xxxx. Configure an IPv4 default route on the ASBR R3 forwarding traffic to R4. Propagate the default routing into OSPFv2.

```
R3(config)# ip route 0.0.0.0 0.0.0.0 192.168.77.1
R3(config)# router ospf 1
R3(config-router)# default-information originate
R3(config-router)#
```

yyyy. Issue the **show ip route static** command on R3 to verify the static route is in the IPv4 routing table.

```
R3# show ip route static
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.77.1 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 192.168.77.1
R3#
```

zzzz. Configure an IPv4 static route on the ASBR, R3 for the 192.168.99.0/24 network on R4. Redistribute the static route into OSPFv2 using the **redistribute static subnets** command. The subnets parameter is used to include subnets and not just classful network addresses. The **redistribute** command is discussed in more detail in later chapters.

```
R3(config)# ip route 192.168.99.0 255.255.255.0 192.168.77.1
R3(config)# router ospf 1
R3(config-router)# redistribute static subnets
```

aaaaa. Issue the **show ip route ospf** command on R1 to verify that the default route and the redistributed static route are being advertised into the OSPFv2 domain.

```
R1# show ip route ospf
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.2.2 to network 0.0.0.0

O*E2  0.0.0.0/0 [110/1] via 192.168.2.2, 00:01:53, Serial0/0/0
O IA  192.168.3.0/24 [110/65] via 192.168.2.2, 00:06:09, Serial0/0/0
      192.168.4.0/30 is subnetted, 1 subnets
O IA     192.168.4.0 [110/128] via 192.168.2.2, 00:06:09, Serial0/0/0
O IA  192.168.5.0/24 [110/129] via 192.168.2.2, 00:06:09, Serial0/0/0
O E2  192.168.99.0/24 [110/20] via 192.168.2.2, 00:01:53, Serial0/0/0
R1#
```

What does the "E2" for the default route and the redistributed external route signify?

Son rutas externas de tipo 2, dadas de forma predeterminadas por que son distribuidas por OSPF

____

____

Step 3: Configure an OSPFv2 stub area.

a. Under the OSPFv2 process on R1 and R2, make area 51 a stub area using the **area** *area* **stub** command. The adjacency between the two routers might go down during the transition period, but it should come back up afterwards.

```
R1(config)# router ospf 1
R1(config-router)# area 51 stub

R2(config)# router ospf 1
R2(config-router)# area 51 stub
```

b. Confirm that both R1 and R2 are neighbors using the **show ip ospf neighbors** command.

```
R1# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
2.2.2.2           0   FULL/  -        00:00:36    192.168.2.2
Serial0/0/0
```

```
R1#

R2# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
3.3.3.3           0   FULL/  -        00:00:37    192.168.4.2
Serial0/0/1
1.1.1.1           0   FULL/  -        00:00:38    192.168.2.1
Serial0/0/0
R2#
```

c. Issue the **show ip route ospf** command on R1. Notice that R1 still has a default route pointing toward R2 but with a different cost than it had prior to being configured in a stub area. This is not the default route propagated by the ASBR R3, but the default route injected by the ABR of the stub area. Also, R1 does not receive any external routes, so it no longer has the external network 192.168.99.0/24 in its routing table. Stub routers continue to receive inter-area routes from area 0.

```
R1# show ip route ospf
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.2.2 to network 0.0.0.0

O*IA  0.0.0.0/0 [110/65] via 192.168.2.2, 00:06:09, Serial0/0/0
O IA  192.168.3.0/24 [110/65] via 192.168.2.2, 00:06:09, Serial0/0/0
      192.168.4.0/30 is subnetted, 1 subnets
O IA     192.168.4.0 [110/128] via 192.168.2.2, 00:06:09, Serial0/0/0
O IA  192.168.5.0/24 [110/129] via 192.168.2.2, 00:06:09, Serial0/0/0
R1#
```

d. View the output of the **show ip ospf** command on ABR R2 to see what type each area is and the number of interfaces in each area.

```
R2# show ip ospf
 Routing Process "ospf 1" with ID 2.2.2.2
 Start time: 01:49:34.272, Time elapsed: 02:04:19.324
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Supports NSSA (compatible with RFC 3101)
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 It is an area border router
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
```

```
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msecs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
Number of external LSA 2. Checksum Sum 0x0174F7
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 2. 1 normal 1 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
   Area BACKBONE(0)
       Number of interfaces in this area is 2
       Area has no authentication
       SPF algorithm last executed 00:23:27.416 ago
       SPF algorithm executed 20 times
       Area ranges are
       Number of LSA 6. Checksum Sum 0x0413D3
       Number of opaque link LSA 0. Checksum Sum 0x000000
       Number of DCbitless LSA 0
       Number of indication LSA 0
       Number of DoNotAge LSA 0
       Flood list length 0
   Area 51
       Number of interfaces in this area is 1
       It is a stub area
       Generates stub default route with cost 1
       Area has no authentication
       SPF algorithm last executed 00:23:17.416 ago
       SPF algorithm executed 4 times
       Area ranges are
       Number of LSA 6. Checksum Sum 0x02E70A
       Number of opaque link LSA 0. Checksum Sum 0x000000
       Number of DCbitless LSA 0
       Number of indication LSA 0
       Number of DoNotAge LSA 0
       Flood list length 0

R2#
```

What are the advantages of having a router receive a default route rather than a more specific route?

Las ventajas se dan en rendimineto, procesamiento y memoria, ya que son asignadas por defecto y no guardadas____

____

Why do all routers in a stub area need to know that the area is a stub?

Para que los router no generen enlaces virtuales en areas donde no deben de existir.______

____

____

Step 4: Configure a totally stubby area.

A modified version of a stubby area is a totally stubby area. A totally stubby area ABR only allows in a single, default route from the backbone, injected by the ABR. To configure a totally stubby area, you only need to change a command at the ABR, R2 in this scenario. Under the router OSPFv2 process, you will enter the **area 51 stub no-summary** command to replace the existing stub command for area 51. The **no-summary** option tells the router that this area will not receive summary (inter-area) routes.

a. To see how this works, issue the **show ip route ospf** command on R1. Notice the inter-area routes, in addition to the default route generated by R2.

```
R1# show ip route ospf
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.2.2 to network 0.0.0.0

O*IA  0.0.0.0/0 [110/65] via 192.168.2.2, 00:28:13, Serial0/0/0
O IA  192.168.3.0/24 [110/65] via 192.168.2.2, 00:28:13, Serial0/0/0
      192.168.4.0/30 is subnetted, 1 subnets
O IA     192.168.4.0 [110/128] via 192.168.2.2, 00:28:13, Serial0/0/0
O IA  192.168.5.0/24 [110/129] via 192.168.2.2, 00:28:13, Serial0/0/0
R1#
```

b. Look at the output of the **show ip ospf database** command on R2 to see which LSAs are in its OSPFv2 database.

```
R2# show ip ospf database

            OSPF Router with ID (2.2.2.2) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link
count
1.1.1.1         1.1.1.1         2231        0x80000002 0x00EECE 2
2.2.2.2         2.2.2.2         41          0x8000000D 0x00E63E 3
3.3.3.3         3.3.3.3         385         0x80000007 0x0071B1 3

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.1.0     1.1.1.1         2241        0x80000002 0x00B616
192.168.1.0     2.2.2.2         1838        0x80000001 0x001D6C
192.168.2.0     2.2.2.2         41          0x80000002 0x00F397

                Router Link States (Area 51)

Link ID         ADV Router      Age         Seq#       Checksum Link
count
```

```
1.1.1.1         1.1.1.1         1847        0x8000000B 0x0043F8 3
2.2.2.2         2.2.2.2         1841        0x8000000A 0x009C16 2

                Summary Net Link States (Area 51)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         2.2.2.2         41          0x80000002 0x0073C1
192.168.3.0     2.2.2.2         41          0x80000007 0x00962D
192.168.4.0     2.2.2.2         41          0x80000007 0x00F194
192.168.5.0     2.2.2.2         41          0x80000007 0x00037E

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
0.0.0.0         3.3.3.3         385         0x80000003 0x00DCC7 1
192.168.99.0    3.3.3.3         385         0x80000002 0x009432 0
R2#
```

c. Enter the **area 51 stub no-summary** command on R2 (the ABR) under the OSPF process.

```
R2(config)# router ospf 1
R2(config-router)# area 51 stub no-summary
```

d. Go back to R1 and issue the **show ip route ospf** command. Notice that it shows only one incoming route from the ABR R2. The default route is injected by the ABR R2. There are no inter-area OSPFv2 routes and no external OSPFv2 routes.

```
R1# show ip route ospf
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B -
BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS
level-2
       ia - IS-IS inter area, * - candidate default, U - per-user
static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l -
LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.2.2 to network 0.0.0.0

O*IA  0.0.0.0/0 [110/65] via 192.168.2.2, 00:01:14, Serial0/0/0
R1#
```

e. Examine the output of the **show ip ospf database** command to see which routes are in area 51. You may need to clear the OSPFv2 process to reset the entries in the OSPF LSDB.

```
R1# clear ip ospf process
Reset ALL OSPF processes? [no]: yes
*Oct  8 03:56:06.802: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on
Serial0/0/0 from FULL to DOWN, Neighbor Down: Interface down or
detached
*Oct  8 03:56:06.894: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on
Serial0/0/0 from LOADING to FULL, Loading Done
R1#
R1# show ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 1)
```

```
                         Router Link States (Area 51)

Link ID         ADV Router      Age         Seq#       Checksum Link
count
1.1.1.1         1.1.1.1         7           0x8000000D 0x003FFA 3
2.2.2.2         2.2.2.2         284         0x8000000B 0x009A17 2

                Summary Net Link States (Area 51)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         2.2.2.2         330         0x80000004 0x006FC3
R1#
```

What are the advantages of making an area totally stubby instead of a regular stub area? What are the disadvantages?

Las ventajas se dan en el ahorro de tiempo en procesamiento y memoria, desventaja es que la agragacion de rutas puede causar la Perdida de paquetes de envio ya que puede leer la ruta como no adecuada para elegir. ____

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Why did only the ABR need to know that the area was totally stubby rather than all routers in the area?

Por que el ABR es la Puerta de enlace a toda la area y limita todas las inter areas por donde deba tranferir. ____

____

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Step 5: Configure multi-area OSPFv3.

Traditional OSPFv3 implements OSPF routing for IPv6. In our dual-stack (IPv4/IPv6) environment we have previously configured OSPFv2 for routing IPv4 and now we will configure OSPFv3 for routing IPv6.

bb. OSPFv3 messages are sourced from the router's IPv6 link-local address. Earlier in this lab, IPv6 GUA and link-local addresses were statically configured on each router's interface. The link-local addresses were configured to make these addresses more recognizable than being automatically created using EUI-64. Issue the **show ipv6 interface brief** command to verify the GUA and link-local addresses on the router's interfaces.

```
R1# show ipv6 interface brief
Em0/0                  [administratively down/down]
    unassigned
GigabitEthernet0/0     [up/up]
    FE80::1
    2001:DB8:CAFE:1::1
GigabitEthernet0/1     [administratively down/down]
    unassigned
Serial0/0/0            [up/up]
    FE80::1
```

```
    2001:DB8:CAFE:2::1
Serial0/0/1            [administratively down/down]
    unassigned
R1#
```

cc. IPv6 routing is disabled by default. The Cisco IOS version used with the routers in this lab has IPv6 CEF enabled by default once IPv6 routing is enabled. To enable IPv6 routing, use the **ipv6 unicast-routing** command in global configuration mode. Use the **show ipv6 cef** command to verify whether IPv6 CEF is enabled. If you need to enable IPv6 CEF, use the **ipv6 cef** command. If IPv6 CEF is disabled you will see the an IOS message similar to "%IPv6 CEF not running:. Enter these commands on routers R1, R2 and R3. IPv6 routing on R4 has been enabled in Step 1.

```
R1(config)# ipv6 unicast-routing
R1(config)# end
R1# show ipv6 cef
::/0
  no route
::/127
  discard
2001:DB8:CAFE:1::/64
  attached to GigabitEthernet0/0
2001:DB8:CAFE:1::1/128
  receive for GigabitEthernet0/0
2001:DB8:CAFE:2::/64
  attached to Serial0/0/0
2001:DB8:CAFE:2::1/128
  receive for Serial0/0/0
FE80::/10
  receive for Null0
FF00::/8
  multicast
R1#

R2(config)# ipv6 unicast-routing

R3(config)# ipv6 unicast-routing
```

dd. Configure the OSPFv3 process on each router. Similar to OSPFv2, the process ID does not have to match other routers to form neighbor adjacencies. Configure the 32-bit OSPFv3 router ID on each router. The OSPFv3 router ID uses the same process as OSPFv2 and is required if there are no IPv4 addresses configured on the router.

Note: The **show ipv6 ospf** command should used to verify the OSPF router ID. If the OSPFv3 router ID is uses a 32-bit value other than the one specified by the **router-id** command, you can reset the router ID by using the **clear ipv6 ospf** *pid* **process** command and re-verify using the command **show ipv6 ospf**.

```
R1(config)# ipv6 router ospf 2
R1(config-rtr)# router-id 1.1.1.1
R1(config-rtr)# exit
R1(config)# interface gigabitethernet 0/0
R1(config-if)# ipv6 ospf 2 area 51
```

```
R1(config-if)# exit
R1(config)# interface serial 0/0/0
R1(config-if)# ipv6 ospf 2 area 51
R1(config-if)#


R2(config)# ipv6 router ospf 2
R2(config-rtr)# router-id 2.2.2.2
R2(config-rtr)# exit
R2(config)# interface serial 0/0/1
R2(config-if)# ipv6 ospf 2 area 0
R2(config-if)# exit
R2(config)# interface gigabitethernet 0/0
R2(config-if)# ipv6 ospf 2 area 0
R2(config-if)# exit
R2(config)# interface serial 0/0/0
R2(config-if)# ipv6 ospf 2 area 51
R2(config-if)#

R3(config)# ipv6 router ospf 2
R3(config-rtr)# router-id 3.3.3.3
R3(config-rtr)# exit
R3(config)# interface gigabitethernet 0/0
R3(config-if)# ipv6 ospf 2 area 0
R3(config-if)# exit
R3(config)# interface serial 0/0/1
R3(config-if)# ipv6 ospf 2 area 0
R3(config-if)#
```

ee. Verify that you have OSPFv3 neighbors with the **show ipv6 ospf neighbor** command. The output for R2 is displayed.

```
R2# show ipv6 ospf neighbor

            OSPFv3 Router with ID (2.2.2.2) (Process ID 2)

Neighbor ID     Pri   State           Dead Time   Interface ID
Interface
3.3.3.3           0   FULL/  -        00:00:36    6
Serial0/0/1
1.1.1.1           0   FULL/  -        00:00:34    6
Serial0/0/0
R2#
```

ff. View the OSPF routes in the IPv6 routing table on all three routers with the **show ipv6 route ospf** command.

```
R1# show ipv6 route ospf
IPv6 Routing Table - default - 8 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D -
EIGRP
```

```
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF
ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
OI  2001:DB8:CAFE:3::/64 [110/65]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:4::/64 [110/128]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:5::/64 [110/129]
     via FE80::2, Serial0/0/0
R1#

R2# show ipv6 route ospf
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D -
EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF
ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
O   2001:DB8:CAFE:1::/64 [110/65]
     via FE80::1, Serial0/0/0
O   2001:DB8:CAFE:5::/64 [110/65]
     via FE80::3, Serial0/0/1
R2#

R3# show ipv6 route ospf
IPv6 Routing Table - default - 10 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D -
EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF
ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
OI  2001:DB8:CAFE:1::/64 [110/129]
     via FE80::2, Serial0/0/1
OI  2001:DB8:CAFE:2::/64 [110/128]
     via FE80::2, Serial0/0/1
```

```
O   2001:DB8:CAFE:3::/64 [110/65]
     via FE80::2, Serial0/0/1
R3#
```

f. Configure an IPv6 default route on the ASBR R3 forwarding traffic to R4. Propagate the default routing into OSPFv3.

```
R3(config)# ipv6 route ::/0 2001:db8:feed:77::1
R3(config)# ipv6 router ospf 2
R3(config-rtr)# default-information originate
R3(config-rtr)#
```

g. Configure an IPv6 static route on the ASBR R3 for the 2001:DB8:99:1::/64 prefix on R4. Redistribute the static route into OSPFv3.

```
R3(config)# ipv6 route 2001:db8:99:1::/64 2001:db8:feed:77::1
R3(config)# ipv6 router ospf 2
R3(config-rtr)# redistribute static
R3(config-rtr)#
```

h. Issue the **show ipv6 route static** command on R3 to verify both static routes is in the IPv6 routing table.

```
R3# show ipv6 route static
IPv6 Routing Table - default - 12 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D -
EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF
ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
S   ::/0 [1/0]
     via 2001:DB8:FEED:77::1
S   2001:DB8:99:1::/64 [1/0]
     via 2001:DB8:FEED:77::1
R3#
```

i. Issue the **show ipv6 route ospf** command on R1 to verify that the default route and the redistributed static route are now being advertised into the OSPFv3 domain.

```
R1# show ipv6 route ospf
IPv6 Routing Table - default - 10 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D -
EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF
ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
```

```
OE2 ::/0 [110/1], tag 2
     via FE80::2, Serial0/0/0
OE2 2001:DB8:99:1::/64 [110/20]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:3::/64 [110/65]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:4::/64 [110/128]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:5::/64 [110/129]
     via FE80::2, Serial0/0/0
R1#
```

Step 6: Configure an OSPFv3 stub area.

a. Configuring stub areas for OSPFv3 is similar to that for OSPFv2. The stub area functionality is the same for OSPFv2 and OSPFv3. Under the OSPFv3 process on R1 and R2, make area 51 a stub area using the **area** *area* **stub** command. The adjacency between the two routers might go down during the transition period, but it should come back up afterwards.

```
R1(config)# ipv6 router ospf 2
R1(config-rtr)# area 51 stub

R2(config)# ipv6 router ospf 2
R2(config-rtr)# area 51 stub
```

b. Confirm that both R1 and R2 are neighbors using the **show ipv6 ospf neighbors** command.

```
R1# show ipv6 ospf neighbor

            OSPFv3 Router with ID (1.1.1.1) (Process ID 2)

Neighbor ID     Pri   State           Dead Time   Interface ID
Interface
2.2.2.2           0   FULL/  -        00:00:36    5
Serial0/0/0
R1#

R2# show ipv6 ospf neighbor

            OSPFv3 Router with ID (2.2.2.2) (Process ID 2)

Neighbor ID     Pri   State           Dead Time   Interface ID
Interface
3.3.3.3           0   FULL/  -        00:00:35    6
Serial0/0/1
1.1.1.1           0   FULL/  -        00:00:34    6
Serial0/0/0
R2#
```

c. To verify that the stub area functionality is the same in OSPFv3 as in OSPFv2 issue the **show ipv6 route ospf** command on R1. Similar to OSPFv2, notice that R1 still has a default route pointing toward R2 but with a different cost than it had prior to being configured in a stub area. Again, this is not the default route propagated by the ASBR R3, but the default route injected by the ABR of the stub area. R1 also does not receive any external routes, so it no longer has the 2001:DB8:99:1::/64 prefix in its routing table. Stub routers continue to receive inter-area routes.

```
R1# show ipv6 route ospf
```

```
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D -
EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF
ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
OI  ::/0 [110/65]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:3::/64 [110/65]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:4::/64 [110/128]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:5::/64 [110/129]
     via FE80::2, Serial0/0/0
R1#
```

Step 7: Configure a totally stubby area.

As mentioned earlier in the lab, a totally stubby area ABR only allows in a single, default route from the backbone, injected by the ABR. Configuring a totally stubby area, you only need to change a command at the ABR, R2 in this scenario. Similar commands used to configure a totally stubby area for the OSPFv2 process are used for OSPFv3.

a. First, issue the **show ipv6 route ospf** command on R1 to verify that inter-area routes, in addition to the default route are being sent by R2.

```
R1#show ipv6 route ospf
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D -
EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF
ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
OI  ::/0 [110/65]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:3::/64 [110/65]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:4::/64 [110/128]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:5::/64 [110/129]
     via FE80::2, Serial0/0/0
R1#
```

b. Enter the **area 51 stub no-summary** command on R2 (the ABR) under the OSPFv3 process.

```
R2(config)# ipv6 router ospf 2
R2(config-rtr)# area 51 stub no-summary
```

c. On R1 and issue the **show ipv6 route ospf** command. Similar to OSPFv2, there is only one incoming route from the ABR R2. The default route is injected by the ABR R2. There are no inter-area OSPFv3 routes and no external OSPFv3 routes.

```
R1# show ipv6 route ospf
IPv6 Routing Table - default - 6 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static
route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D -
EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF
ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
OI  ::/0 [110/65]
     via FE80::2, Serial0/0/0
R1#
```

d. View the output of the **show ipv6 ospf** command on ABR R2 to see what type each area is and the number of interfaces in each area.

```
R2# show ipv6 ospf
 Routing Process "ospfv3 2" with ID 2.2.2.2
 Supports NSSA (compatible with RFC 3101)
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 It is an area border router
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Retransmission limit dc 24 non-dc 24
 Number of external LSA 2. Checksum Sum 0x00FD33
 Number of areas in this router is 2. 1 normal 1 stub 0 nssa
 Graceful restart helper support enabled
 Reference bandwidth unit is 100 mbps
 RFC1583 compatibility enabled
    Area BACKBONE(0)
        Number of interfaces in this area is 2
        SPF algorithm executed 7 times
        Number of LSA 9. Checksum Sum 0x0539E9
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
    Area 51
        Number of interfaces in this area is 1
        It is a stub area, no summary LSA in this area
        Generates stub default route with cost 1
        SPF algorithm executed 5 times
        Number of LSA 7. Checksum Sum 0x028798
        Number of DCbitless LSA 0
        Number of indication LSA 0
```

```
        Number of DoNotAge LSA 0
        Flood list length 0

R2#
```

El router #2 presenta una ruta unica entro del area 51, es por que la ruta es bastante ancha.

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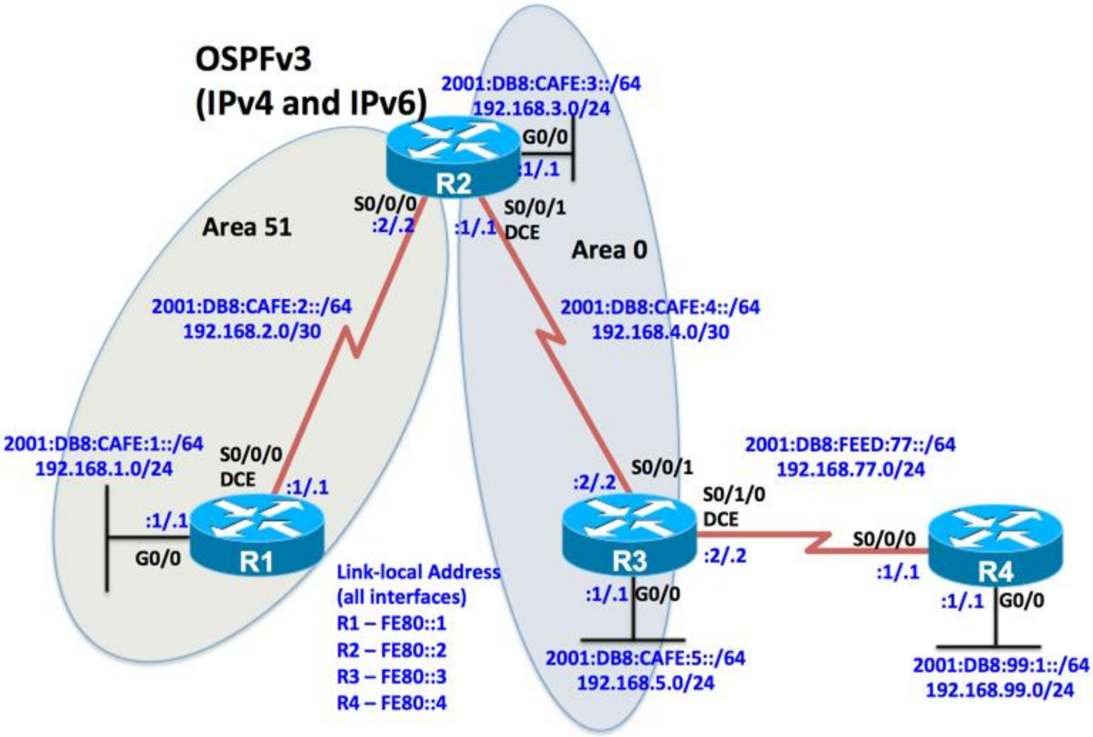
Lab 3-3, OSPFv3 Address Families

Topology



Objectives

- Configure multi-area OSPFv3 for IPv4 AF.
- Configure multi-area OSPFv3 for IPv6 AF.
- Verify multi-area behavior.
- Configure stub and totally stubby areas for both IPv4 and IPv6 AFs.

Background

In this lab, you will configure the network with multi-area OSPFv3 routing using the address family feature for both IPv4 and IPv6. For both OSPFv2 and OSPFv3, area 51 will be configured as a normal OSPF area, a stub area and then a totally stubby area.

Note: This lab uses Cisco 1941 routers with Cisco IOS Release 15.4 with IP Base. The switches are Cisco WS-C2960-24TT-L with Fast Ethernet interfaces, therefore the router will use routing metrics associated with a 100 Mb/s interface. Depending on the router or switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 4 routers (Cisco IOS Release 15.2 or comparable)
- 4 switches (LAN interfaces)
- Serial and Ethernet cables

Step 0: Suggested starting configurations.

a. Apply the following configuration to each router along with the appropriate **hostname**. The **exec-timeout 0 0** command should only be used in a lab environment.

```
Router(config)# no ip domain-lookup
Router(config)# line con 0
Router(config-line)# logging synchronous
Router(config-line)# exec-timeout 0 0
```

Step 1: Configure the addressing and serial links.

a. Using the topology, configure the IPv4 and IPv6 addresses on the interfaces of each router.

```
R1(config)# interface GigabitEthernet0/0
R1(config-if)# ip address 192.168.1.1 255.255.255.0
R1(config-if)# ipv6 address FE80::1 link-local
R1(config-if)# ipv6 address 2001:DB8:CAFE:1::1/64
R1(config-if)# no shutdown
R1(config-if)# exit
R1(config)# interface Serial0/0/0
R1(config-if)# ip address 192.168.2.1 255.255.255.252
R1(config-if)# ipv6 address FE80::1 link-local
R1(config-if)# ipv6 address 2001:DB8:CAFE:2::1/64
R1(config-if)# clock rate 64000
R1(config-if)# no shutdown

R2(config)# interface GigabitEthernet0/0
R2(config-if)# ip address 192.168.3.1 255.255.255.0
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:3::1/64
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Serial0/0/0
R2(config-if)# ip address 192.168.2.2 255.255.255.252
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:2::2/64
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Serial0/0/1
R2(config-if)# ip address 192.168.4.1 255.255.255.252
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:4::1/64
R2(config-if)# clock rate 64000
R2(config-if)# no shutdown

R3(config)# interface GigabitEthernet0/0
R3(config-if)# ip address 192.168.5.1 255.255.255.0
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:CAFE:5::1/64
R3(config-if)# no shutdown
```

```
R3(config-if)# exit
R3(config)# interface Serial0/0/1
R3(config-if)# ip address 192.168.4.2 255.255.255.252
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:CAFE:4::2/64
R3(config-if)# no shutdown
R3(config-if)# exit
R3(config)# interface Serial0/1/0
R3(config-if)# ip address 192.168.77.2 255.255.255.0
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:FEED:77::2/64
R3(config-if)# clock rate 64000
R3(config-if)# no shutdown
R3(config-if)#

R4(config)# interface Serial0/0/0
R4(config-if)# ip address 192.168.77.1 255.255.255.0
R4(config-if)# ipv6 address FE80::4 link-local
R4(config-if)# ipv6 address 2001:DB8:FEED:77::1/64
R4(config-if)# no shutdown
R4(config-if)# exit

R4(config)# interface gigabitethernet 0/0
R4(config-if)# ip address 192.168.99.1 255.255.255.0
R4(config-if)# ipv6 address 2001:db8:99:1::1/64
R4(config-if)# no shutdown
R4(config-if)# exit
R4(config)# ipv6 unicast-routing
R4(config)# ipv6 route 2001:DB8:CAFE::/48 2001:DB8:FEED:77::2
R4(config)# ip route 0.0.0.0 0.0.0.0 192.168.77.2
R4(config)#
```

b. Verify connectivity by pinging across each of the local networks connected to each router.

c. Issue the **show ip interface brief** and the **show ipv6 interface brief** command on each router. These commands display a brief listing of the interfaces, their status, and their IP addresses. Router R1 is shown as an example.

```
R1# show ip interface brief
Interface                  IP-Address      OK? Method Status
Protocol
Embedded-Service-Engine0/0 unassigned      YES unset  administratively down
down
GigabitEthernet0/0         192.168.1.1     YES manual up
up
GigabitEthernet0/1         unassigned      YES unset  administratively down
down
Serial0/0/0                192.168.2.1     YES manual up
up
Serial0/0/1                unassigned      YES unset  administratively down
down
R1# show ipv6 interface brief
Em0/0                  [administratively down/down]
    unassigned
GigabitEthernet0/0     [up/up]
    FE80::1
```

```
    2001:DB8:CAFE:1::1
GigabitEthernet0/1     [administratively down/down]
    unassigned
Serial0/0/0            [up/up]
    FE80::1
    2001:DB8:CAFE:2::1
Serial0/0/1            [administratively down/down]
    unassigned
R1#
```

Step 2: Configure and verify OSPFv3 address families for IPv4 and IPv6.

OSPFv3 with the addresses family (AF) unifies OSPF configuration for both IPv4 and IPv6. OSPFv3 with address families also combines neighbor tables and the LSDB under a single OSPF process. OSPFv3 messages are sent over IPv6 and therefore requires that IPv6 routing is enabled and that the interface has a link-local IPv6 address. This is the requirement even if only the IPv4 AF is configured.

Note: After configuring the OSPFv3 address families, the **show ospfv3** command should used to verify the OSPF router ID for both the IPv4 and IPv6 AF. If the OSPF router ID is using a 32-bit value other than the one specified by the **router-id** command, you can reset the router ID by using the **clear ospfv3** *pid* **process** command and re-verify using the command **show ospfv3**.

a. After enabling IPv6 unicast routing, configure the OSPFv4 IPv4 AF on R3 using the **router ospf** *pid* command. The **?** is used to see the two address families available.

```
R3(config)# ipv6 unicast-routing
R3(config)# router ospfv3 1
R3(config-router)# address-family ?
  ipv4  Address family
  ipv6  Address family
R3(config-router)#
```

b. Enter the IPv4 address family configuration mode using the command **address-family ipv4 unicast**. The **?** is used to examine the options in the address-family configuration mode. Some of the more common configuration commands are high-lighted. Use the **router-id** command to configure the router ID for the IPv4 AF.

```
R3(config-router)# address-family ipv4 unicast
R3(config-router-af)# ?
Router Address Family configuration commands:
  area                     OSPF area parameters
  authentication           Authentication parameters
  auto-cost                Calculate OSPF interface cost according to
bandwidth
  bfd                      BFD configuration commands
  compatible               Compatibility list
  default                  Set a command to its defaults
  default-information      Control distribution of default information
  default-metric           Set metric of redistributed routes
  discard-route            Enable or disable discard-route installation
  distance                 Define an administrative distance
  distribute-list          Filter networks in routing updates
  event-log                Event Logging
  exit-address-family      Exit from Address Family configuration mode
  graceful-restart         Graceful-restart options
  help                     Description of the interactive help system
  interface-id             Source of the interface ID
  limit                    Limit a specific OSPF feature
  local-rib-criteria       Enable or disable usage of local RIB as route
criteria
  log-adjacency-changes    Log changes in adjacency state
  max-lsa                  Maximum number of non self-generated LSAs to
accept
  max-metric               Set maximum metric
  maximum-paths            Forward packets over multiple paths
  no                       Negate a command or set its defaults
```

```
  passive-interface       Suppress routing updates on an interface
  prefix-suppression      Enable prefix suppression
  queue-depth             Hello/Router process queue depth
  redistribute            Redistribute information from another routing
protocol
  router-id               router-id for this OSPF process
  shutdown                Shutdown the router process
  snmp                    Modify snmp parameters
  summary-prefix          Configure IP address summaries
  timers                  Adjust routing timers

R3(config-router-af)# router-id 3.3.3.3
R3(config-router-af)#
```

c. Use the **passive-interface** command to configure the G0/0 interface as passive for the IPv4 AF.

```
R3(config-router-af)# passive-interface gigabitethernet 0/0
```

d. Exit the IPv4 address family configuration mode and enter the IPv6 address configuration mode. The **exit-address-family** (or a shorter version of **exit**) command is used exit address family configuration mode. Issue the **address-family ipv6 unicast** command to enter the IPv6 AF. For the IPv6 AF, use the **router-id** command to configure the router ID and the passive-interface command to configure G0/0 as a passive interface. Although it isn't necessary, a different router ID is being used for the IPv6 AF. The **exit** command is used to return to global configuration mode.

```
R3(config-router-af)# exit-address-family
R3(config-router)# address-family ipv6 unicast
R3(config-router-af)# router-id 3.3.3.6
R3(config-router-af)# passive-interface gigabitethernet 0/0
R3(config-router-af)# exit-address-family
R3(config-router)# exit
R3(config)#
```

e. OSPFv3 is enabled directly on the interfaces for both IPv4 and IPv6 AFs using the **ospfv3** *pid* [**ipv4** | **ipv6**] **area** *area-id* interface command. Use this command to enable OSPFv3 on both of R3's interfaces in area 0.

```
R3(config)# interface gigabitethernet 0/0
R3(config-if)# ospfv3 1 ipv4 area 0
R3(config-if)# ospfv3 1 ipv6 area 0
R3(config-if)# exit
R3(config)# interface serial 0/0/1
R3(config-if)# ospfv3 1 ipv4 area 0
R3(config-if)# ospfv3 1 ipv6 area 0
R3(config-if)#
```

f. Apply similar commands used on R3 to configure OSPFv3 IPv4 and IPv6 AFs on R2. Router R2 is an ABR so be sure to configure the proper area ID to each interface. The OSPF process ID does not need to match other routers.

```
R2(config)# router ospfv3 1
R2(config-router)# address-family ipv4 unicast
R2(config-router-af)# router-id 2.2.2.2
R2(config-router-af)# passive-interface gigabitethernet 0/0
R2(config-router-af)# exit-address-family
R2(config-router)# address-family ipv6 unicast
R2(config-router-af)# router-id 2.2.2.6
R2(config-router-af)# passive-interface gigabitethernet 0/0
R2(config-router-af)# exit-address-family
R2(config-router)# interface serial 0/0/1
R2(config-if)# ospfv3 1 ipv4 area 0
R2(config-if)# ospfv3 1 ipv6 area 0
R2(config-if)# exit
R2(config)# interface gigabitethernet 0/0
R2(config-if)# ospfv3 1 ipv4 area 0
R2(config-if)# ospfv3 1 ipv6 area 0
R2(config-if)# exit
```

```
R2(config)# interface serial 0/0/0
R2(config-if)# ospfv3 1 ipv4 area 51
R2(config-if)# ospfv3 1 ipv6 area 51
R2(config-if)#
```

g. Finally, issue these same type of commands to configure OSPFv3 for the IPv4 and IPv6 AFs on R1, an internal router in area 51.

```
R1(config)# ipv6 unicast-routing
R1(config)# router ospfv3 1
R1(config-router)# address-family ipv4 unicast
R1(config-router-af)# router-id 1.1.1.1
R1(config-router-af)# passive-interface gigabitethernet 0/0
R1(config-router-af)# exit-address-family
R1(config-router)# address-family ipv6 unicast
R1(config-router-af)# router-id 1.1.1.6
R1(config-router-af)# passive-interface gigabitethernet 0/0
R1(config-router-af)# exit-address-family
R1(config-router)# exit
R1(config)# interface gigabitethernet 0/0
R1(config-if)# ospfv3 1 ipv4 area 51
R1(config-if)# ospfv3 1 ipv6 area 51
R1(config-if)# exit
R1(config)# interface serial 0/0/0
R1(config-if)# ospfv3 1 ipv4 area 51
R1(config-if)# ospfv3 1 ipv6 area 51
R1(config-if)#
```

h. Verify that the routers have OSPFv3 neighbors. First, issue both the **show ip ospf neighbors** and **show ipv6 ospf neighbors** command on R2. Notice which router IDs are displayed in the **show ipv6 ospf neighbor** output.

```
R2# show ip ospf neighbor
R2#
R2# show ipv6 ospf neighbor

            OSPFv3 Router with ID (2.2.2.6) (Process ID 1)

Neighbor ID     Pri   State           Dead Time   Interface ID    Interface
3.3.3.6           0   FULL/  -        00:00:39    6
Serial0/0/1
1.1.1.6           0   FULL/  -        00:00:36    6
Serial0/0/0
R2#
```

Why doesn't the **show ip ospf neighbor** command display any output?

RTA: El comando show ip ospf neighbor se utiliza para mostrar adyacencias vecinas OSPFv2. R2 se ha configurado utilizando OSPFv3, por lo que no vecino adyacencias se muestran.

Why does the **show ipv6 ospf neighbor** command only display OSPFv3 neighbors in the IPv6 AF?

RTA: El comando show ipv6 ospf neighbor se utiliza para mostrar adyacencias vecinas OSPFv3, específicamente para IPv6 indicadas por la palabra clave ipv6 en el comando. El router ID 1.1.1.6 y 3.3.3.6 están asociados con el IPv6 AF.

i. Issue the **show ospfv3 neighbor** command to verify OSPFv3 neighbor adjacencies for both the IPv4 and IPv6 AFs. The output for R2 is displayed.

```
R2# show ospfv3 neighbor

          OSPFv3 1 address-family ipv4 (router-id 2.2.2.2)

Neighbor ID     Pri   State           Dead Time   Interface ID    Interface
3.3.3.3           0   FULL/  -        00:00:30    6
Serial0/0/1
1.1.1.1           0   FULL/  -        00:00:34    6
Serial0/0/0

          OSPFv3 1 address-family ipv6 (router-id 2.2.2.6)
```

```
Neighbor ID     Pri   State           Dead Time   Interface ID    Interface
3.3.3.6           0   FULL/  -        00:00:30    6
Serial0/0/1
1.1.1.6           0   FULL/  -        00:00:35    6
Serial0/0/0
R2#
```

j. The IPv4 and IPv6 routing tables can be verified by using the **show ip route** and **show ipv6 route** commands. Each router should see all IPv4 networks and IPv6 prefixes in the OSPFv3 routing domain including those with passive interfaces. The output for R3 is shown below.

```
R3# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-
2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

O IA  192.168.1.0/24 [110/129] via 192.168.4.1, 00:07:37, Serial0/0/1
      192.168.2.0/30 is subnetted, 1 subnets
O IA     192.168.2.0 [110/128] via 192.168.4.1, 00:07:37, Serial0/0/1
O     192.168.3.0/24 [110/65] via 192.168.4.1, 00:07:47, Serial0/0/1
      192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.4.0/30 is directly connected, Serial0/0/1
L        192.168.4.2/32 is directly connected, Serial0/0/1
      192.168.5.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.5.0/24 is directly connected, GigabitEthernet0/0
L        192.168.5.1/32 is directly connected, GigabitEthernet0/0
      192.168.77.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.77.0/24 is directly connected, Serial0/1/0
L        192.168.77.2/32 is directly connected, Serial0/1/0
R3#
R3# show ipv6 route
IPv6 Routing Table - default - 10 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
OI  2001:DB8:CAFE:1::/64 [110/129]
     via FE80::2, Serial0/0/1
OI  2001:DB8:CAFE:2::/64 [110/128]
     via FE80::2, Serial0/0/1
O   2001:DB8:CAFE:3::/64 [110/65]
     via FE80::2, Serial0/0/1
C   2001:DB8:CAFE:4::/64 [0/0]
     via Serial0/0/1, directly connected
L   2001:DB8:CAFE:4::2/128 [0/0]
     via Serial0/0/1, receive
C   2001:DB8:CAFE:5::/64 [0/0]
     via GigabitEthernet0/0, directly connected
```

```
L   2001:DB8:CAFE:5::1/128 [0/0]
     via GigabitEthernet0/0, receive
C   2001:DB8:FEED:77::/64 [0/0]
     via Serial0/1/0, directly connected
L   2001:DB8:FEED:77::2/128 [0/0]
     via Serial0/1/0, receive
L   FF00::/8 [0/0]
     via Null0, receive
R3#
```

k. Understanding the difference between commands associated with OSPFv2 and OSPFv3 can seem challenging at times. The **show ip route ospfv3** command is used to view OSPFv3 routes in the IPv4 routing table. The **show ipv6 route ospf** command is used to view OSPFv3 routes in the IPv6 routing table. The **show ipv6 route ospf** command is the same command used in with traditional OSPFv3 for IPv6.

```
R3# show ip route ospf
R3#
R3# show ip route ospfv3
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-
2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

O IA  192.168.1.0/24 [110/129] via 192.168.4.1, 00:17:13, Serial0/0/1
      192.168.2.0/30 is subnetted, 1 subnets
O IA     192.168.2.0 [110/128] via 192.168.4.1, 00:17:13, Serial0/0/1
O     192.168.3.0/24 [110/65] via 192.168.4.1, 00:17:23, Serial0/0/1
R3#
R3# show ipv6 route ospf
IPv6 Routing Table - default - 10 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
OI  2001:DB8:CAFE:1::/64 [110/129]
     via FE80::2, Serial0/0/1
OI  2001:DB8:CAFE:2::/64 [110/128]
     via FE80::2, Serial0/0/1
O   2001:DB8:CAFE:3::/64 [110/65]
     via FE80::2, Serial0/0/1
R3#
```

Why doesn't the **show ip route ospf** command display any routes?

RTA: El comando show ip route ospf se utiliza para mostrar rutas OSPFv2 en la tabla de enrutamiento IPv4. R3 está usando OSPFv3.

l. Configure IPv4 and IPv6 default routes on the ASBR R3 forwarding traffic to R4. Propagate both default routes into OSPFv3 within the appropriate address family.

```
R3(config)# ip route 0.0.0.0 0.0.0.0 192.168.77.1
R3(config)# ipv6 route ::/0 2001:db8:feed:77::1
R3(config)# router ospfv3 1
R3(config-router)# address-family ipv4 unicast
R3(config-router-af)# default-information originate
R3(config-router-af)# exit-address-family
R3(config-router)# address-family ipv6 unicast
R3(config-router-af)# default-information originate
R3(config-router-af)# exit-address-family
R3(config-router)# end
R3#
```

m. Issue the **show ip route static** and **show ipv6 route static** commands on R3 to verify the static route is in the IPv4 and IPv6 routing tables.

```
R3# show ip route static
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-
2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.77.1 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 192.168.77.1
R3# show ipv6 route static
IPv6 Routing Table - default - 11 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
S   ::/0 [1/0]
     via 2001:DB8:FEED:77::1
R3#
```

n. Configure IPv4 and IPv6 static routes on the ASBR, R3 for the 192.168.99.0/24 and 2001:db8:99:1::/64 network on R4. Redistribute the static route into OSPFv3 IPv4 and IPv6 AFs using the **redistribute static** command in each address family configuration mode. The **redistribute** command is discussed in more detail in later chapters.

```
R3(config)# ip route 192.168.99.0 255.255.255.0 192.168.77.1
R3(config)# ipv6 route 2001:db8:99:1::/64 2001:db8:feed:77::1
R3(config)# router ospfv3 1
R3(config-router)# address-family ipv4 unicast
R3(config-router-af)# redistribute static
R3(config-router-af)# exit-address-family
R3(config-router)# address-family ipv6 unicast
R3(config-router-af)# redistribute static
R3(config-router-af)# end
R3#
```

o. Issue the **show ip route ospfv3** and **show ipv6 route ospf** commands on R1 to verify that the default route and the redistributed static route are being advertised into the OSPFv3 domain.

```
R1# show ip route ospfv3
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-
2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.2.2 to network 0.0.0.0

O*E2  0.0.0.0/0 [110/1] via 192.168.2.2, 00:13:18, Serial0/0/0
O IA  192.168.3.0/24 [110/65] via 192.168.2.2, 00:54:00, Serial0/0/0
      192.168.4.0/30 is subnetted, 1 subnets
O IA     192.168.4.0 [110/128] via 192.168.2.2, 00:54:00, Serial0/0/0
O IA  192.168.5.0/24 [110/129] via 192.168.2.2, 00:54:00, Serial0/0/0
O E2  192.168.99.0/24 [110/20] via 192.168.2.2, 00:03:40, Serial0/0/0
R1#
R1# show ipv6 route ospf
IPv6 Routing Table - default - 10 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
OE2 ::/0 [110/1], tag 1
     via FE80::2, Serial0/0/0
OE2 2001:DB8:99:1::/64 [110/20]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:3::/64 [110/65]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:4::/64 [110/128]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:5::/64 [110/129]
     via FE80::2, Serial0/0/0
R1#
```

Step 3: Configure an OSPFv2 stub area.

a. Under the OSPFv3 process for R1 and R2, for both the IPv4 and IPv6 AFs, configure area 51 as a stub area using the **area** *area* **stub** command. The adjacency between the two routers might go down during the transition period, but it should come back up afterwards.

```
R1(config)# router ospfv3 1
R1(config-router)# address-family ipv4 unicast
R1(config-router-af)# area 51 stub
R1(config-router-af)# exit-address-family
R1(config-router)# address-family ipv6 unicast
R1(config-router-af)# area 51 stub

R2(config)# router ospfv3 1
R2(config-router)# address-family ipv4 unicast
R2(config-router-af)# area 51 stub
R2(config-router-af)# exit-address-family
R2(config-router)# address-family ipv6 unicast
```

```
R2(config-router-af)# area 51 stub
```

b. Confirm that both R1 and R2 are neighbors for both IPv4 and IPv6 AFs using the **show ospfv3 neighbors** command on R2.

```
R2# show ospfv3 neighbor

          OSPFv3 1 address-family ipv4 (router-id 2.2.2.2)

Neighbor ID     Pri   State           Dead Time   Interface ID    Interface
3.3.3.3           0   FULL/  -        00:00:34    6
Serial0/0/1
1.1.1.1           0   FULL/  -        00:00:32    6
Serial0/0/0

          OSPFv3 1 address-family ipv6 (router-id 2.2.2.6)

Neighbor ID     Pri   State           Dead Time   Interface ID    Interface
3.3.3.6           0   FULL/  -        00:00:36    6
Serial0/0/1
1.1.1.6           0   FULL/  -        00:00:32    6
Serial0/0/0
R2#
```

c. Issue the **show ip route ospfv3** and **show ipv6 route ospf** commands on R1. Notice that R1 still has a default route pointing toward R2 but with a different cost than it had prior to being configured in a stub area. This is not the default route propagated by the ASBR R1, but the default route injected by the ABR of the stub area. R1 also does not receive any external routes, so it no longer has the 192.168.99.0/24 or the 2001:DB8:99:1::/64 networks in its IPv4 and IPv6 routing tables. Stub routers continue to receive inter-area routes.

```
R1# show ip route ospfv3
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-
2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.2.2 to network 0.0.0.0

O*IA  0.0.0.0/0 [110/65] via 192.168.2.2, 00:07:17, Serial0/0/0
O IA  192.168.3.0/24 [110/65] via 192.168.2.2, 00:07:17, Serial0/0/0
      192.168.4.0/30 is subnetted, 1 subnets
O IA     192.168.4.0 [110/128] via 192.168.2.2, 00:07:17, Serial0/0/0
O IA  192.168.5.0/24 [110/129] via 192.168.2.2, 00:07:17, Serial0/0/0
R1#
R1# show ipv6 route ospf
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
```

```
OI   ::/0 [110/65]
      via FE80::2, Serial0/0/0
OI   2001:DB8:CAFE:3::/64 [110/65]
      via FE80::2, Serial0/0/0
OI   2001:DB8:CAFE:4::/64 [110/128]
      via FE80::2, Serial0/0/0
OI   2001:DB8:CAFE:5::/64 [110/129]
      via FE80::2, Serial0/0/0
R1#
```

d. View the output of the **show ospfv3** command on ABR R2 to see what type each area is and the number of interfaces in each area. Prior to issuing this command notice the **show ip ospf** command displays no output. Once again, this command is for OSPFv2, we are using OSPFv3. The **show ip ospfv3** command might seem like a logical alternative, however it is not a legitimate option. OSPFv3 is a single process for both IPv4 and IPv6 address families, so the correct command is **show ospfv3**. This will display OSPFv3 information for both AFs.

```
R2# show ip ospf
R2#
R2# show ip ospfv3
               ^
% Invalid input detected at '^' marker.

R2# show ospfv3
 OSPFv3 1 address-family ipv4
 Router ID 2.2.2.2
 Supports NSSA (compatible with RFC 3101)
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 It is an area border router
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Retransmission limit dc 24 non-dc 24
 Number of external LSA 2. Checksum Sum 0x012EE4
 Number of areas in this router is 2. 1 normal 1 stub 0 nssa
 Graceful restart helper support enabled
 Reference bandwidth unit is 100 mbps
 RFC1583 compatibility enabled
    Area BACKBONE(0)
        Number of interfaces in this area is 2
        SPF algorithm executed 4 times
        Number of LSA 9. Checksum Sum 0x03231F
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
    Area 51
        Number of interfaces in this area is 1
        It is a stub area
        Generates stub default route with cost 1
        SPF algorithm executed 5 times
        Number of LSA 10. Checksum Sum 0x03F9E0
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

```
 OSPFv3 1 address-family ipv6
 Router ID 2.2.2.6
 Supports NSSA (compatible with RFC 3101)
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 It is an area border router
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Retransmission limit dc 24 non-dc 24
 Number of external LSA 2. Checksum Sum 0x00CD5F
 Number of areas in this router is 2. 1 normal 1 stub 0 nssa
 Graceful restart helper support enabled
 Reference bandwidth unit is 100 mbps
 RFC1583 compatibility enabled
    Area BACKBONE(0)
        Number of interfaces in this area is 2
        SPF algorithm executed 6 times
        Number of LSA 9. Checksum Sum 0x05479C
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
    Area 51
        Number of interfaces in this area is 1
        It is a stub area
        Generates stub default route with cost 1
        SPF algorithm executed 6 times
        Number of LSA 10. Checksum Sum 0x052FC7
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

R2#
```

Step 4: Configure a totally stubby area.

Remember that a totally stubby area is a modified version of a stubby area. A totally stubby area ABR only allows in a single, default route from the backbone, injected by the ABR. To configure a totally stubby area, you only need to change a command at the ABR, R2 in this scenario. Under the router OSPFv3 process, you will enter the **area 51 stub no-summary** command for both the IPv4 and IPv6 AFs to replace the existing stub command for area 51. The **no-summary** option tells the router that this area will not receive summary (inter-area) routes.

a. To see how this works, issue the **show ip route ospfv3** and **show ipv6 route ospf** commands on R1. Notice the inter-area routes, in addition to the default route generated by R2.

```
R1# show ip route ospfv3
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-
2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
```

```
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.2.2 to network 0.0.0.0

O*IA  0.0.0.0/0 [110/65] via 192.168.2.2, 00:07:17, Serial0/0/0
O IA  192.168.3.0/24 [110/65] via 192.168.2.2, 00:07:17, Serial0/0/0
      192.168.4.0/30 is subnetted, 1 subnets
O IA     192.168.4.0 [110/128] via 192.168.2.2, 00:07:17, Serial0/0/0
O IA  192.168.5.0/24 [110/129] via 192.168.2.2, 00:07:17, Serial0/0/0
R1#
R1# show ipv6 route ospf
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
OI  ::/0 [110/65]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:3::/64 [110/65]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:4::/64 [110/128]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:5::/64 [110/129]
     via FE80::2, Serial0/0/0
R1#
```

b. Look at the output of the **show ospfv3 database** command on R2 to see which LSAs are in its OSPFv3 database. Notice that both the IPv4 and IPv6 AF LSAs are in the same LSDB. You will also notice OSPFv3 changed the names of two types of LSAs and added two others. For a comparison of OSPFv2 and OSPFv3 LSAs go to: https://supportforums.cisco.com/document/97766/comparing-ospfv3-ospfv2-routing-protocol

```
R2# show ospfv3 database

          OSPFv3 1 address-family ipv4 (router-id 2.2.2.2)

                Router Link States (Area 0)

ADV Router       Age         Seq#        Fragment ID  Link count  Bits
 2.2.2.2         1251        0x80000007  0            1           B
 3.3.3.3         764         0x80000009  0            1           E

                Inter Area Prefix Link States (Area 0)

ADV Router       Age         Seq#        Prefix
 2.2.2.2         1251        0x80000003  192.168.2.0/30
 2.2.2.2         1245        0x80000001  192.168.1.0/24

                Link (Type-8) Link States (Area 0)

ADV Router       Age         Seq#        Link ID    Interface
 2.2.2.2         1251        0x80000003  3          Gi0/0
 2.2.2.2         1251        0x80000003  6          Se0/0/1
 3.3.3.3         1275        0x80000004  6          Se0/0/1

                Intra Area Prefix Link States (Area 0)

ADV Router       Age         Seq#        Link ID    Ref-lstype  Ref-LSID
```

```
 2.2.2.2         1251        0x80000003  0           0x2001       0
 3.3.3.3         1275        0x80000004  0           0x2001       0

                Router Link States (Area 51)

ADV Router       Age         Seq#        Fragment ID  Link count  Bits
 1.1.1.1         1248        0x80000007  0            1           None
 2.2.2.2         1247        0x80000008  0            1           B

                Inter Area Prefix Link States (Area 51)

ADV Router       Age         Seq#        Prefix
 2.2.2.2         1251        0x80000003  192.168.5.0/24
 2.2.2.2         1251        0x80000003  192.168.4.0/30
 2.2.2.2         1251        0x80000003  192.168.3.0/24
 2.2.2.2         1255        0x80000001  0.0.0.0/0

                Link (Type-8) Link States (Area 51)

ADV Router       Age         Seq#        Link ID     Interface
 1.1.1.1         1250        0x80000004  6           Se0/0/0
 2.2.2.2         1250        0x80000006  5           Se0/0/0

                Intra Area Prefix Link States (Area 51)

ADV Router       Age         Seq#        Link ID     Ref-lstype  Ref-LSID
 1.1.1.1         1250        0x80000003  0           0x2001      0
 2.2.2.2         1251        0x80000005  0           0x2001      0

                Type-5 AS External Link States

ADV Router       Age         Seq#        Prefix
 3.3.3.3         764         0x80000002  0.0.0.0/0
 3.3.3.3         259         0x80000002  192.168.99.0/24

          OSPFv3 1 address-family ipv6 (router-id 2.2.2.6)

                Router Link States (Area 0)

ADV Router       Age         Seq#        Fragment ID  Link count  Bits
 2.2.2.6         1287        0x80000008  0            1           B
 3.3.3.6         752         0x8000000C  0            1           E

                Inter Area Prefix Link States (Area 0)

ADV Router       Age         Seq#        Prefix
 2.2.2.6         1287        0x80000003  2001:DB8:CAFE:2::/64
 2.2.2.6         1228        0x80000001  2001:DB8:CAFE:1::/64

                Link (Type-8) Link States (Area 0)

ADV Router       Age         Seq#        Link ID     Interface
 2.2.2.6         1287        0x80000003  3           Gi0/0
 2.2.2.6         1287        0x80000003  6           Se0/0/1
 3.3.3.6         1268        0x80000003  6           Se0/0/1

                Intra Area Prefix Link States (Area 0)

ADV Router       Age         Seq#        Link ID     Ref-lstype  Ref-LSID
 2.2.2.6         1287        0x80000003  0           0x2001      0
 3.3.3.6         1268        0x80000003  0           0x2001      0
```

```
                    Router Link States (Area 51)

ADV Router       Age         Seq#        Fragment ID  Link count  Bits
 1.1.1.6         1233        0x80000008  0            1           None
 2.2.2.6         1232        0x8000000A  0            1           B

                    Inter Area Prefix Link States (Area 51)

ADV Router       Age         Seq#        Prefix
 2.2.2.6         1287        0x80000003  2001:DB8:CAFE:4::/64
 2.2.2.6         1287        0x80000003  2001:DB8:CAFE:3::/64
 2.2.2.6         1287        0x80000003  2001:DB8:CAFE:5::/64
 2.2.2.6         1240        0x80000001  ::/0

                    Link (Type-8) Link States (Area 51)

ADV Router       Age         Seq#        Link ID    Interface
 1.1.1.6         1304        0x80000004  6          Se0/0/0
 2.2.2.6         1240        0x80000004  5          Se0/0/0

                    Intra Area Prefix Link States (Area 51)

ADV Router       Age         Seq#        Link ID    Ref-lstype  Ref-LSID
 1.1.1.6         1390        0x80000003  0          0x2001      0
 2.2.2.6         1287        0x80000003  0          0x2001      0

                    Type-5 AS External Link States

ADV Router       Age         Seq#        Prefix
 3.3.3.6         752         0x80000002  ::/0
 3.3.3.6         243         0x80000002  2001:DB8:99:1::/64
R2#
```

c. Enter the **area 51 stub no-summary** command on R2 (the ABR) for both IPv4 and IPv6 AFs in the OSPFv3 process.

```
R2(config)# router ospfv3 1
R2(config-router)# address-family ipv4 unicast
R2(config-router-af)# area 51 stub no-summary
R2(config-router-af)# exit-address-family
R2(config-router)# address-family ipv6 unicast
R2(config-router-af)# area 51 stub no-summary
R2(config-router-af)#
```

d. Go back to R1 and issue the **show ip route ospfv3** and **show ipv6 route ospf** commands. Notice that both routing tables only show a single incoming route from the ABR R2, the default route. The default route is injected by the ABR R2. There are no inter-area OSPFv3 routes and no external OSPFv3 routes.

```
R1# show ip route ospfv3
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-
2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 192.168.2.2 to network 0.0.0.0
```

```
O*IA  0.0.0.0/0 [110/65] via 192.168.2.2, 00:30:38, Serial0/0/0
R1#
R1# show ipv6 route ospf
IPv6 Routing Table - default - 6 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       a - Application
OI  ::/0 [110/65]
     via FE80::2, Serial0/0/0
R1#
```

e. View the output of the **show ospfv3** command on ABR R2 to see what type each area is and the number of interfaces in each area.

```
R2# show ospfv3
 OSPFv3 1 address-family ipv4
 Router ID 2.2.2.2
 Supports NSSA (compatible with RFC 3101)
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 It is an area border router
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Retransmission limit dc 24 non-dc 24
 Number of external LSA 2. Checksum Sum 0x012CE5
 Number of areas in this router is 2. 1 normal 1 stub 0 nssa
 Graceful restart helper support enabled
 Reference bandwidth unit is 100 mbps
 RFC1583 compatibility enabled
    Area BACKBONE(0)
        Number of interfaces in this area is 2
        SPF algorithm executed 5 times
        Number of LSA 9. Checksum Sum 0x031327
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
    Area 51
        Number of interfaces in this area is 1
        It is a stub area, no summary LSA in this area
        Generates stub default route with cost 1
        SPF algorithm executed 6 times
        Number of LSA 7. Checksum Sum 0x035902
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

 OSPFv3 1 address-family ipv6
 Router ID 2.2.2.6
```

```
 Supports NSSA (compatible with RFC 3101)
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 It is an area border router
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Retransmission limit dc 24 non-dc 24
 Number of external LSA 2. Checksum Sum 0x00CB60
 Number of areas in this router is 2. 1 normal 1 stub 0 nssa
 Graceful restart helper support enabled
 Reference bandwidth unit is 100 mbps
 RFC1583 compatibility enabled
    Area BACKBONE(0)
        Number of interfaces in this area is 2
        SPF algorithm executed 7 times
        Number of LSA 9. Checksum Sum 0x0537A4
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
    Area 51
        Number of interfaces in this area is 1
        It is a stub area, no summary LSA in this area
        Generates stub default route with cost 1
        SPF algorithm executed 7 times
        Number of LSA 7. Checksum Sum 0x02E9F0
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

R2#
```

Why does R2 generate a stub default route into area 51? Is this the default route advertised by the ASBR?

RTA: R2 está generando la ruta por defecto en el área 51 porque es un ABR y el área 51 se ha configurado como un área totalmente stubby. La ruta predeterminada no es la ruta anunciada por el ASBR R3.

f. View the output of the **show ip protocols and show ipv6 protocols** commands on R2.

```
R2# show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "application"
  Sending updates every 0 seconds
  Invalid after 0 seconds, hold down 0, flushed after 0
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Maximum path: 32
  Routing for Networks:
  Routing Information Sources:
    Gateway         Distance      Last Update
  Distance: (default is 4)

Routing Protocol is "ospfv3 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
```

```
  Router ID 2.2.2.2
  Area border router
  Number of areas: 1 normal, 1 stub, 0 nssa
  Interfaces (Area 0):
    Serial0/0/1
    GigabitEthernet0/0
  Interfaces (Area 51):
    Serial0/0/0
  Maximum path: 4
  Routing Information Sources:
    Gateway         Distance      Last Update
    3.3.3.3              110      00:02:26
    1.1.1.1              110      00:02:26
  Distance: (default is 110)

R2# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "application"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "ospf 1"
  Router ID 2.2.2.6
  Area border router
  Number of areas: 1 normal, 1 stub, 0 nssa
  Interfaces (Area 0):
    Serial0/0/1
    GigabitEthernet0/0
  Interfaces (Area 51):
    Serial0/0/0
  Redistribution:
    None
R2#
```

Is there any information in the output of these commands that indicate G0/0 is a passive interface?

RTA: No, la salida no muestra información para interfaces pasivas.

g. View the output of the **show ospfv3 interface gigabitethernet 0/0** command on R2.

```
R2# show ospfv3 interface gigabitethernet 0/0
GigabitEthernet0/0 is up, line protocol is up
  Link Local Address FE80::2, Interface ID 3
  Internet Address 192.168.3.1/24
  Area 0, Process ID 1, Instance ID 64, Router ID 2.2.2.2
  Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 2.2.2.2, local address FE80::2
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    No Hellos (Passive interface)
  Graceful restart helper support enabled
  Index 1/1/1, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
GigabitEthernet0/0 is up, line protocol is up
  Link Local Address FE80::2, Interface ID 3
  Area 0, Process ID 1, Instance ID 0, Router ID 2.2.2.6
  Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 2.2.2.6, local address FE80::2
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
```

```
    No Hellos (Passive interface)
  Graceful restart helper support enabled
  Index 1/1/1, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
R2#
```

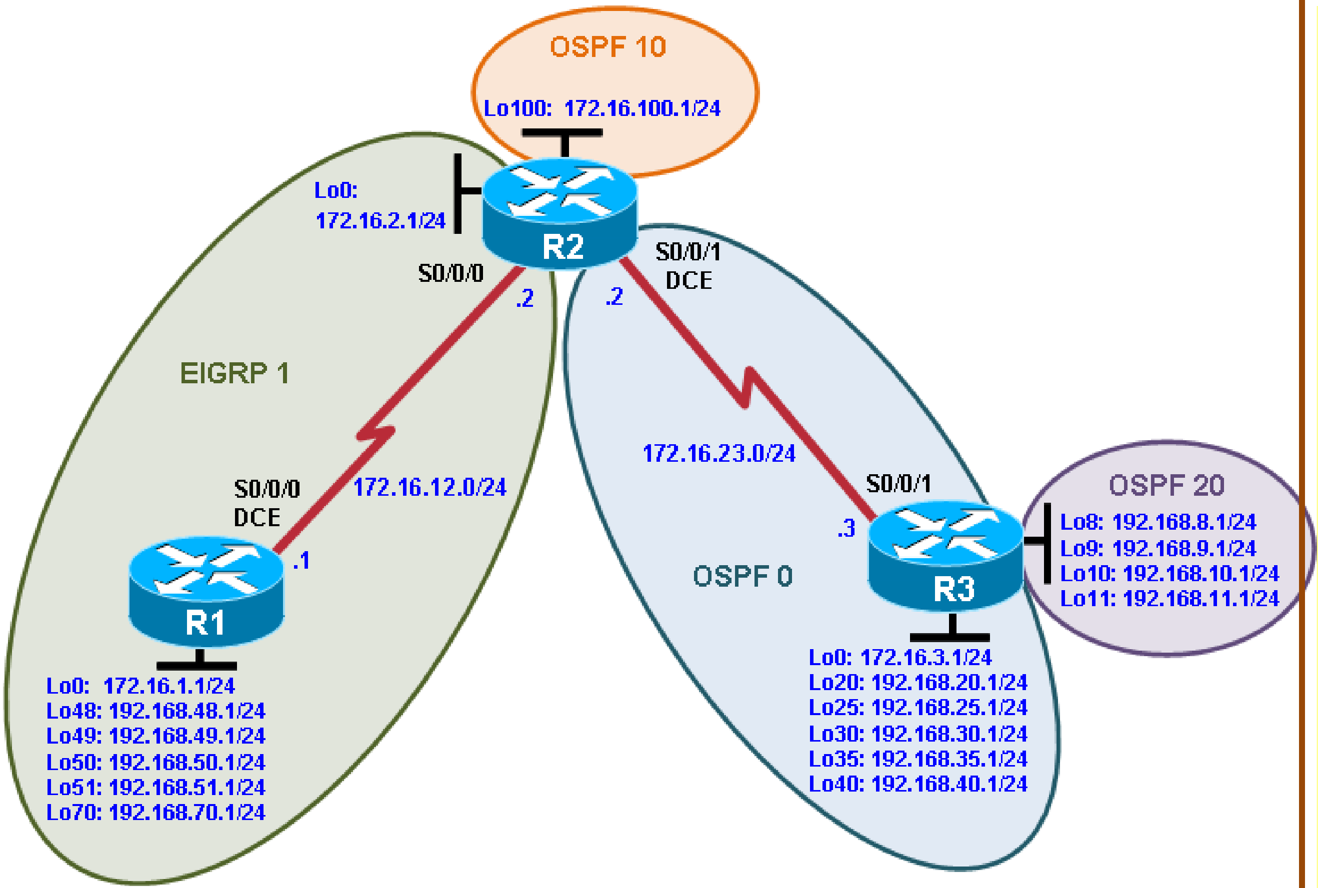
Is there any information in the output of this command that indicate G0/0 is a passive interface?
RTA: Sí, "No hay ayuda (interfaz pasiva)".
Why are there two sets of output for the G0/0 interface?
RTA: Un conjunto de salida es para OSPFv3 IPv4 AF y el otro conjunto es para el IPv6 AF. Observe las diferentes ID de enrutador que se configuraron para cada AF.

```
R1(config)# interface GigabitEthernet0/0
R1(config-if)# ip address 192.168.1.1 255.255.255.0
R1(config-if)# ipv6 address FE80::1 link-local
R1(config-if)# ipv6 address 2001:DB8:CAFE:1::1/64
R1(config-if)# no shutdown
R1(config-if)# exit
R1(config)# interface Serial0/0/0
R1(config-if)# ip address 192.168.2.1 255.255.255.252
R1(config-if)# ipv6 address FE80::1 link-local
R1(config-if)# ipv6 address 2001:DB8:CAFE:2::1/64
R1(config-if)# clock rate 64000
R1(config-if)# no shutdown

R2(config)# interface GigabitEthernet0/0
R2(config-if)# ip address 192.168.3.1 255.255.255.0
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:3::1/64
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Serial0/0/0
R2(config-if)# ip address 192.168.2.2 255.255.255.252
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:2::2/64
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)# interface Serial0/0/1
R2(config-if)# ip address 192.168.4.1 255.255.255.252
R2(config-if)# ipv6 address FE80::2 link-local
R2(config-if)# ipv6 address 2001:DB8:CAFE:4::1/64
R2(config-if)# clock rate 64000
R2(config-if)# no shutdown

R3(config)# interface GigabitEthernet0/0
R3(config-if)# ip address 192.168.5.1 255.255.255.0
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:CAFE:5::1/64
```

```
R3(config-if)# no shutdown
R3(config-if)# exit
R3(config)# interface Serial0/0/1
R3(config-if)# ip address 192.168.4.2 255.255.255.252
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:CAFE:4::2/64
R3(config-if)# no shutdown
R3(config-if)# exit
R3(config)# interface Serial0/1/0
R3(config-if)# ip address 192.168.77.2 255.255.255.0
R3(config-if)# ipv6 address FE80::3 link-local
R3(config-if)# ipv6 address 2001:DB8:FEED:77::2/64
R3(config-if)# clock rate 64000
R3(config-if)# no shutdown
R3(config-if)#

R4(config)# interface Serial0/0/0
R4(config-if)# ip address 192.168.77.1 255.255.255.0
R4(config-if)# ipv6 address FE80::4 link-local
R4(config-if)# ipv6 address 2001:DB8:FEED:77::1/64
R4(config-if)# no shutdown
R4(config-if)# exit
R4(config)# interface gigabitethernet 0/0
R4(config-if)# ip address 192.168.99.1 255.255.255.0
R4(config-if)# ipv6 address 2001:db8:99:1::1/64
R4(config-if)# no shutdown
R4(config-if)# exit
R4(config)# ipv6 unicast-routing
R4(config)# ipv6 route 2001:DB8:CAFE::/48 2001:DB8:FEED:77::2
R4(config)# ip route 0.0.0.0 0.0.0.0 192.168.77.2
R4(config)#
```

Lab 4-1, Redistribution Between EIGRP and OSPF

Topology



Objectives

- Review EIGRP and OSPF configuration.
- Summarize routes in EIGRP.
- Summarize in OSPF at an ABR.
- Redistribute into EIGRP.
- Redistribute into OSPF.
- Summarize in OSPF at an ASBR.

Background

Two online booksellers, Example.com and Example.net, have merged and now need a short-term solution to inter-domain routing. Since these companies provide client services to Internet users, it is essential to have minimal downtime during the transition.
Example.com is running EIGRP while Example.net is running a multi-area OSPF. Because it is imperative that the two booksellers continuously deliver Internet services, you should bridge these two routing domains without interfering with each router's path through its own routing domain to the Internet.
The CIO determines that it is preferable to keep the two protocol domains shown in the diagram during the transition period, because the network engineers on each side need to understand the other's network before deploying a long-term solution. Redistribution will be a short-term solution.
In this scenario, R1 and R2 are running EIGRP while R2 is the OSPF autonomous system border router (ASBR) consisting of areas 0, 10, and 20. You need to configure R2 to enable these two routing protocols to interact to allow full connectivity between all networks.
In this lab, R1 is running EIGRP and R3 is running multi-area OSPF. Your task is to configure redistribution on R2 to enable these two routing protocols to interact, allowing full connectivity between all networks.
Note: This lab uses Cisco 1941 routers with Cisco IOS Release 15.2 with IP Base. Depending on the router or switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 3 routers (Cisco IOS Release 15.2 or comparable)
- Serial and Ethernet cables

Step 1: Configure loopbacks and assign addresses.

a. Configure all loopback interfaces on the three routers in the diagram. Configure the serial interfaces with the IP addresses, bring them up, and set a DCE clock rate where appropriate.

```
R1(config)# interface Loopback0
R1(config-if)# ip address 172.16.1.1 255.255.255.0
R1(config-if)# exit
R1(config)# interface Loopback48
R1(config-if)# ip address 192.168.48.1 255.255.255.0
R1(config-if)# exit
R1(config)# interface Loopback49
R1(config-if)# ip address 192.168.49.1 255.255.255.0
R1(config-if)# exit
R1(config)# interface Loopback50
R1(config-if)# ip address 192.168.50.1 255.255.255.0
R1(config-if)# exit
R1(config)# interface Loopback51
R1(config-if)# ip address 192.168.51.1 255.255.255.0
R1(config-if)# exit
R1(config)# interface Loopback70
R1(config-if)# ip address 192.168.70.1 255.255.255.0
R1(config-if)# exit
R1(config)# interface Serial0/0/0
R1(config-if)# ip address 172.16.12.1 255.255.255.0
R1(config-if)# clock rate 64000
R1(config-if)# bandwidth 64
R1(config-if)# no shutdown

R2(config)# interface Loopback0
R2(config-if)# ip address 172.16.2.1 255.255.255.0
R2(config-if)# exit
R2(config)# interface loopback 100
R2(config-if)# ip address 172.16.100.1 255.255.255.0
R2(config-if)# exit
R2(config)# interface Serial0/0/0
R2(config-if)# ip address 172.16.12.2 255.255.255.0
R2(config-if)# bandwidth 64
R2(config-if)# no shutdown
R2(config-if)# exit
```

```
R2(config)# interface Serial0/0/1
R2(config-if)# ip address 172.16.23.2 255.255.255.0
R2(config-if)# clock rate 64000
R2(config-if)# bandwidth 64
R2(config-if)# no shutdown

R3(config)# interface Loopback0
R3(config-if)# ip address 172.16.3.1 255.255.255.0
R3(config-if)# exit
R3(config)# interface loopback 8
R3(config-if)# ip address 192.168.8.1 255.255.255.0
R3(config-if)# exit
R3(config)# interface loopback 9
R3(config-if)# ip address 192.168.9.1 255.255.255.0
R3(config-if)# exit
R3(config)# interface loopback 10
R3(config-if)# ip address 192.168.10.1 255.255.255.0
R3(config-if)# exit
R3(config)# interface loopback 11
R3(config-if)# ip address 192.168.11.1 255.255.255.0
R3(config-if)# exit
R3(config)# interface Loopback20
R3(config-if)# ip address 192.168.20.1 255.255.255.0
R3(config-if)# exit
R3(config)# interface Loopback25
R3(config-if)# ip address 192.168.25.1 255.255.255.0
R3(config-if)# exit
R3(config)# interface Loopback30
R3(config-if)# ip address 192.168.30.1 255.255.255.0
R3(config-if)# exit
R3(config)# interface Loopback35
R3(config-if)# ip address 192.168.35.1 255.255.255.0
R3(config-if)# exit
R3(config)# interface Loopback40
R3(config-if)# ip address 192.168.40.1 255.255.255.0
R3(config-if)# exit
R3(config)# interface Serial0/0/1
R3(config-if)# ip address 172.16.23.3 255.255.255.0
R3(config-if)# bandwidth 64
R3(config-if)# no shutdown
```

```
R2(config)#interface Loopback100

R2(config-if)#
%LINK-5-CHANGED: Interface Loopback100, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback100, changed state to up

R2(config-if)#ip address 172.16.100.1 255.255.255.0
R2(config-if)#exit
R2(config)#interface Serial0/0/0
R2(config-if)#ip address 172.16.12.2 255.255.255.0
R2(config-if)#bandwidth 64
R2(config-if)#no shutdown

R2(config-if)#
%LINK-5-CHANGED: Interface Serial0/0/0, changed state to up

R2(config-if)#interface Serial0/0/1
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up

R2(config-if)#ip address 172.16.23.2 255.255.255.0
R2(config-if)#clock rate 64000
R2(config-if)#bandwidth 64
R2(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0/1, changed state to down
R2(config-if)#
```

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b. Verify that you can ping across the serial links when you are finished. Use the following Tcl script to check full and partial connectivity throughout this lab.

```
R1# tclsh

foreach address {
172.16.1.1
192.168.48.1
192.168.49.1
192.168.50.1
192.168.51.1
192.168.70.1
172.16.12.1
172.16.12.2
172.16.2.1
172.16.100.1
172.16.23.2
172.16.23.3
172.16.3.1
192.168.8.1
192.168.9.1
192.168.10.1
192.168.11.1
192.168.20.1
192.168.25.1
192.168.30.1
192.168.35.1
192.168.40.1
} { ping $address }
```

Which pings are successful and why?

RTA: En este punto, sólo las interfaces directamente conectadas tendrán éxito. Por ejemplo, R1 debería hacer ping exitosamente a las primeras ocho direcciones IP (de

172.16.1.1 a 172.16.12.2) en la lista y fallar para todas las demás direcciones IP, ya que no están conectadas directamente a redes.

Step 2: Configure EIGRP.

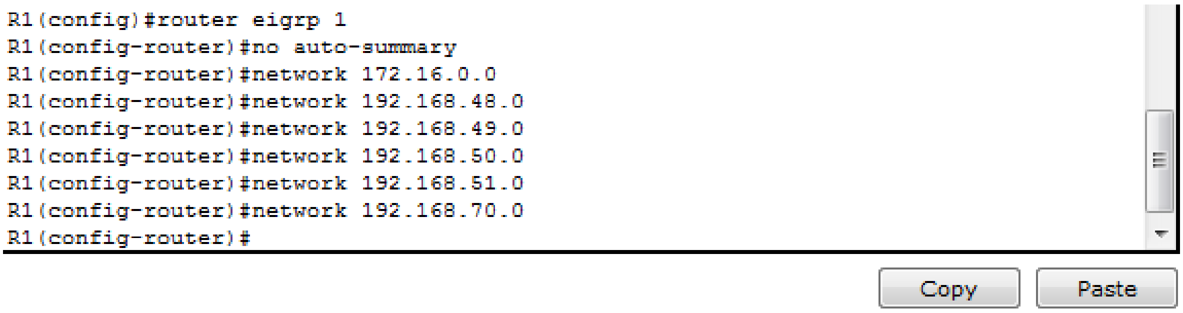
a. Configure R1 and R2 to run EIGRP in autonomous system 1. On R1, add in all connected interfaces either with classful **network** commands or with wildcard masks. Use a classful **network** statement on R2 and disable automatic summarization.

R1(config)# **router eigrp 1**
R1(config-router)# **no auto-summary**
R1(config-router)# **network 172.16.0.0**
R1(config-router)# **network 192.168.48.0**
R1(config-router)# **network 192.168.49.0**
R1(config-router)# **network 192.168.50.0**
R1(config-router)# **network 192.168.51.0**
R1(config-router)# **network 192.168.70.0**

or

R1(config)# **router eigrp 1**
R1(config-router)# **no auto-summary**
R1(config-router)# **network 172.16.0.0**
R1(config-router)# **network 192.168.0.0 0.0.255.255**

R2(config)# **router eigrp 1**
R2(config-router)# **no auto-summary**
R2(config-router)# **network 172.16.0.0**

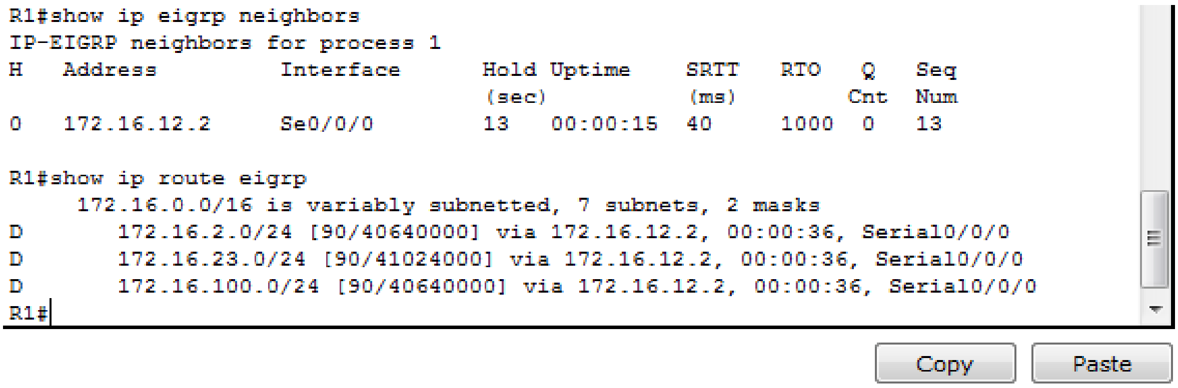


b. Verify the EIGRP configuration using the **show ip eigrp neighbors** and **show ip route eigrp** commands on R1.

R1# **show ip eigrp neighbors**
EIGRP-IPv4 Neighbors for AS(1)
H   Address   Interface   Hold Uptime   SRTT   RTO
Q   Seq
(sec)   (ms)
Cnt Num
0   172.16.12.2   Se0/0/0   10 00:00:22   42   2340
0   3
R1#
R1# **show ip route eigrp**

<Output omitted>

```
      172.16.0.0/16 is variably subnetted, 7 subnets, 2 masks
D        172.16.2.0/24 [90/40640000] via 172.16.12.2, 00:00:31,
Serial0/0/0
D        172.16.23.0/24 [90/41024000] via 172.16.12.2, 00:00:31,
Serial0/0/0
D        172.16.100.0/24 [90/40640000] via 172.16.12.2, 00:00:31,
Serial0/0/0
R1#
```



```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address         Interface      Hold Uptime    SRTT   RTO   Q   Seq
                                   (sec)          (ms)         Cnt Num
0   172.16.12.2     Se0/0/0        13   00:00:15  40     1000  0   13

R1#show ip route eigrp
     172.16.0.0/16 is variably subnetted, 7 subnets, 2 masks
D       172.16.2.0/24 [90/40640000] via 172.16.12.2, 00:00:36, Serial0/0/0
D       172.16.23.0/24 [90/41024000] via 172.16.12.2, 00:00:36, Serial0/0/0
D       172.16.100.0/24 [90/40640000] via 172.16.12.2, 00:00:36, Serial0/0/0
R1#
```


c. Verify the EIGRP configuration on R2.

```
R2# show ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(1)
H   Address                 Interface       Hold Uptime   SRTT   RTO
Q  Seq
                                            (sec)         (ms)

Cnt Num
0   172.16.12.1             Se0/0/0           11 00:04:14   35   2340
0  3
R2#
R2# show ip route eigrp

<Output omitted>

      172.16.0.0/16 is variably subnetted, 9 subnets, 2 masks
D        172.16.1.0/24 [90/40640000] via 172.16.12.1, 00:01:40,
Serial0/0/0
D     192.168.48.0/24 [90/40640000] via 172.16.12.1, 00:01:40,
Serial0/0/0
D     192.168.49.0/24 [90/40640000] via 172.16.12.1, 00:01:40,
Serial0/0/0
D     192.168.50.0/24 [90/40640000] via 172.16.12.1, 00:01:40,
Serial0/0/0
D     192.168.51.0/24 [90/40640000] via 172.16.12.1, 00:01:40,
Serial0/0/0
D     192.168.70.0/24 [90/40640000] via 172.16.12.1, 00:01:40,
Serial0/0/0
R2#
```

d. Verify that R1 and R2 can reach all of the networks in the EIGRP routing domain using the following Tcl script.

```
R1# tclsh

foreach address {
172.16.1.1
192.168.48.1
192.168.49.1
192.168.50.1
192.168.51.1
192.168.70.1
172.16.12.1
172.16.12.2
172.16.2.1
} { ping $address }
```

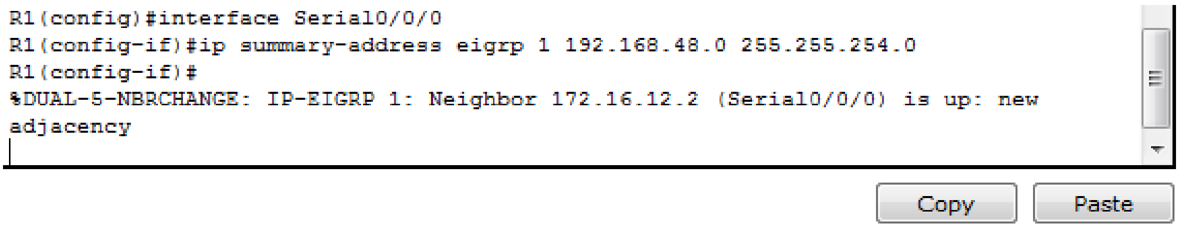
All pings should be successful. Troubleshoot if necessary.

Step 3: Manually summarize with EIGRP.

To make routing updates more efficient and ultimately reduce the size of routing tables, contiguous EIGRP routes can be summarized out an interface by using the **ip summary-address eigrp** *as network mask* interface configuration command.

a. On R1, advertise one supernet route summarizing the networks of loopback 48 and 49 to R2.

```
R1(config)# interface Serial0/0/0
R1(config-if)# ip summary-address eigrp 1 192.168.48.0 255.255.254.0
R1(config-if)#
*Oct 26 15:46:36.839: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1: Neighbor
172.16.12.2 (Serial0/0/0) is resync: summary configured
R1(config-if)# exit
R1#
```



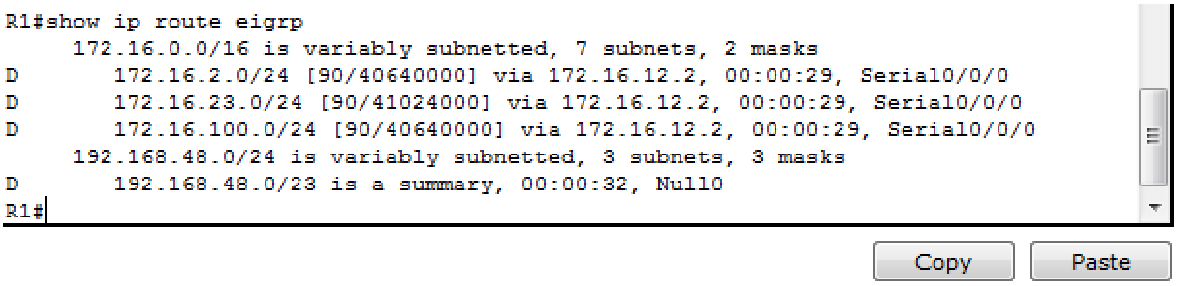
b. Verify the routing table of R1 using the **show ip route eigrp** command.

```
R1# show ip route eigrp

<Output omitted>

     172.16.0.0/24 is subnetted, 6 subnets
D       172.16.23.0 [90/41024000] via 172.16.12.2, 00:45:21,
Serial0/0/0
D       172.16.2.0 [90/40640000] via 172.16.12.2, 00:45:21,
Serial0/0/0
D       172.16.100.0 [90/40640000] via 172.16.12.2, 00:08:12,
Serial0/0/0
D    192.168.48.0/23 is a summary, 04:27:07, Null0

R1#
```



```
R1#show ip route eigrp
     172.16.0.0/16 is variably subnetted, 7 subnets, 2 masks
D       172.16.2.0/24 [90/40640000] via 172.16.12.2, 00:00:29, Serial0/0/0
D       172.16.23.0/24 [90/41024000] via 172.16.12.2, 00:00:29, Serial0/0/0
D       172.16.100.0/24 [90/40640000] via 172.16.12.2, 00:00:29, Serial0/0/0
     192.168.48.0/24 is variably subnetted, 3 subnets, 3 masks
D       192.168.48.0/23 is a summary, 00:00:32, Null0
R1#
```


Notice how EIGRP now has a route to the summarized address going to the Null 0 interface in the routing table.

c. Verify the specifics for the summarized routes using the **show ip route 192.168.48.0 255.255.254.0** command on R1.

```
R1# show ip route 192.168.48.0 255.255.254.0
Routing entry for 192.168.48.0/23, supernet
  Known via "eigrp 1", distance 5, metric 128256, type internal
  Redistributing via eigrp 1
  Routing Descriptor Blocks:
  * directly connected, via Null0
      Route metric is 128256, traffic share count is 1
      Total delay is 5000 microseconds, minimum bandwidth is 
10000000 Kbit
      Reliability 255/255, minimum MTU 1514 bytes
      Loading 1/255, Hops 0
```

Notice the low administrative distance (AD) for this route. Why does EIGRP add the summarized route pointing to the Null 0 interface with a low AD?

RTA: EIGRP crea automáticamente una ruta de resumen a la interfaz Null0 porque es el origen del resumen. Tiene conocimiento de todas las subredes existentes anunciadas por la ruta de resumen. Si recibe un paquete destinado a la ruta de resumen, pero la ruta existe, entonces el paquete se eliminará (enviado a Null0) en lugar de ser reenviado a otra puerta de enlace predeterminada.

d. Verify the routing table of R2 using the **show ip route eigrp** command.

```
R2# show ip route eigrp

<Output omitted>

      172.16.0.0/16 is variably subnetted, 9 subnets, 2 masks
D        172.16.1.0/24 [90/40640000] via 172.16.12.1, 00:09:49, 
Serial0/0/0
D     192.168.48.0/23 [90/40640000] via 172.16.12.1, 00:09:49, 
Serial0/0/0
D     192.168.50.0/24 [90/40640000] via 172.16.12.1, 00:09:49, 
Serial0/0/0
D     192.168.51.0/24 [90/40640000] via 172.16.12.1, 00:09:49, 
Serial0/0/0
D     192.168.70.0/24 [90/40640000] via 172.16.12.1, 00:09:49, 
Serial0/0/0
R2#
```

Notice how the routing table is slightly smaller as the entry to 192.168.49.0/24 is now missing. However, 192.168.49.1 is still reachable due to the summarized route to 192.168.48.0/23. Verify by pinging the loopback 49 interface from R2.

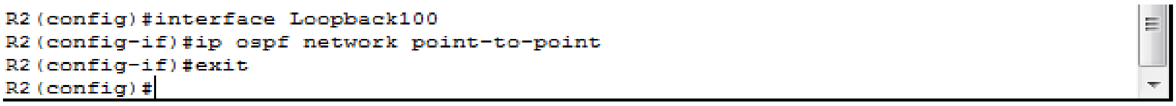
```
R2# ping 192.168.49.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.49.1, timeout is 2
seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/28/28
ms
R2#
```

Step 4: Configure OSPF.

By default, loopback interfaces are advertised as a host route with a /32 mask. To advertise them as network routes, the loopback interface network type must be changed point-to-point. In this step, you will advertise the loopback interfaces as point-to-point and configure multi-area OSPF between R2 and R3.

a. On R2, configure the loopback 100 interface as a point-to-point network.

```
R2(config)# interface Loopback100
R2(config-if)# ip ospf network point-to-point
R2(config-if)# exit
R2(config)#
```



```
R2(config)#interface Loopback100
R2(config-if)#ip ospf network point-to-point
R2(config-if)#exit
R2(config)#
```

b. Next advertise serial link connecting to R3 in area 0 and the loopback 100 network is area 10.

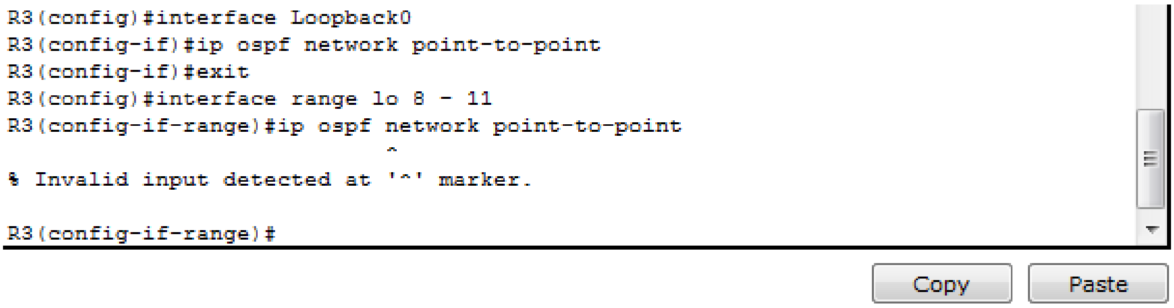
```
R2(config)# router ospf 1
R2(config-router)# network 172.16.23.0 0.0.0.255 area 0
R2(config-router)# network 172.16.100.0 0.0.0.255 area 10
```

c. On R3, change the network type for the 10 loopback interfaces to point-to-point so that they are advertised with the correct subnet mask (/24 instead of /32). Start with loopback 0.

```
R3(config)# interface Loopback0
R3(config-if)# ip ospf network point-to-point
R3(config-if)# exit
```

d. Although we could manually configure all 9 other interface individually, we can also use the **interface range** command to simultaneously configure several interfaces. Loopback interfaces are contiguous and therefore configured by using a hyphen. The remainder of the interfaces are separated using a comma.

```
R3(config)# interface range lo 8 - 11
R3(config-if-range)# ip ospf network point-to-point
R3(config-if-range)# exit
R3(config)#
R3(config)# interface range lo 20, lo 25, lo 30, lo 35, lo 40
R3(config-if-range)# ip ospf network point-to-point
R3(config-if-range)# exit
R3(config)#
```

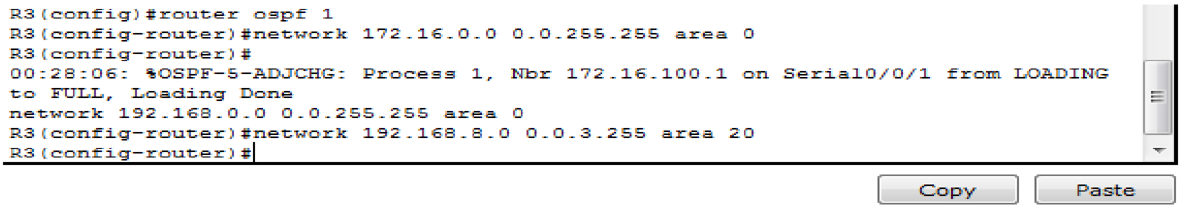


```
R3(config)#interface Loopback0
R3(config-if)#ip ospf network point-to-point
R3(config-if)#exit
R3(config)#interface range lo 8 - 11
R3(config-if-range)#ip ospf network point-to-point
                                   ^
% Invalid input detected at '^' marker.

R3(config-if-range)#
```


e. On R3, include the serial link and all loopback interfaces in area 0 and the loopbacks in area 20.

```
R3(config)# router ospf 1
R3(config-router)# network 172.16.0.0 0.0.255.255 area 0
R3(config-router)# network 192.168.0.0 0.0.255.255 area 0
R3(config-router)# network 192.168.8.0 0.0.3.255 area 20
R3(config-router)#
*Jul 27 08:22:05.503: %OSPF-5-ADJCHG: Process 1, Nbr 172.16.100.1 on
Serial0/0/1 from LOADING to FULL, Loading Done
R3(config-router)#
```



```
R3(config)#router ospf 1
R3(config-router)#network 172.16.0.0 0.0.255.255 area 0
R3(config-router)#
00:28:06: %OSPF-5-ADJCHG: Process 1, Nbr 172.16.100.1 on Serial0/0/1 from LOADING
to FULL, Loading Done
network 192.168.0.0 0.0.255.255 area 0
R3(config-router)#network 192.168.8.0 0.0.3.255 area 20
R3(config-router)#
```


f. Verify that your adjacencies come up with the **show ip ospf neighbor** command, and make sure that you have routes from OSPF populating the R2 routing table using the **show ip route ospf** command.

```
R2# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
192.168.40.1      0   FULL/  -        00:00:39    172.16.23.3
Serial0/0/1
R2#
R2# show ip route ospf

<Output omitted>

      172.16.0.0/16 is variably subnetted, 10 subnets, 2 masks
O        172.16.3.0/24 [110/1563] via 172.16.23.3, 00:04:24,
Serial0/0/1
O IA  192.168.8.0/24 [110/1563] via 172.16.23.3, 00:04:24,
Serial0/0/1
O IA  192.168.9.0/24 [110/1563] via 172.16.23.3, 00:04:24,
Serial0/0/1
O IA  192.168.10.0/24 [110/1563] via 172.16.23.3, 00:04:24,
Serial0/0/1
O IA  192.168.11.0/24 [110/1563] via 172.16.23.3, 00:04:24,
Serial0/0/1
```

```
O      192.168.20.0/24 [110/1563] via 172.16.23.3, 00:04:24,
Serial0/0/1
O      192.168.25.0/24 [110/1563] via 172.16.23.3, 00:04:24,
Serial0/0/1
O      192.168.30.0/24 [110/1563] via 172.16.23.3, 00:04:24,
Serial0/0/1
O      192.168.35.0/24 [110/1563] via 172.16.23.3, 00:04:24,
Serial0/0/1
O      192.168.40.0/24 [110/1563] via 172.16.23.3, 00:04:24,
Serial0/0/1
R2#
```

```
R2#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.40.1      0   FULL/  -        00:00:35    172.16.23.3     Serial0/0/1
R2#show ip route ospf
     172.16.0.0/16 is variably subnetted, 10 subnets, 2 masks
O       172.16.3.0 [110/1563] via 172.16.23.3, 00:00:55, Serial0/0/1
     192.168.8.0/32 is subnetted, 1 subnets
O       192.168.8.1 [110/1563] via 172.16.23.3, 00:00:55, Serial0/0/1
     192.168.9.0/32 is subnetted, 1 subnets
O       192.168.9.1 [110/1563] via 172.16.23.3, 00:00:45, Serial0/0/1
     192.168.10.0/32 is subnetted, 1 subnets
O       192.168.10.1 [110/1563] via 172.16.23.3, 00:00:45, Serial0/0/1
     192.168.11.0/32 is subnetted, 1 subnets
O       192.168.11.1 [110/1563] via 172.16.23.3, 00:00:45, Serial0/0/1
     192.168.20.0/32 is subnetted, 1 subnets
O       192.168.20.1 [110/1563] via 172.16.23.3, 00:00:45, Serial0/0/1
     192.168.25.0/32 is subnetted, 1 subnets
O       192.168.25.1 [110/1563] via 172.16.23.3, 00:00:45, Serial0/0/1
     192.168.30.0/32 is subnetted, 1 subnets
O       192.168.30.1 [110/1563] via 172.16.23.3, 00:00:45, Serial0/0/1
     192.168.35.0/32 is subnetted, 1 subnets
O       192.168.35.1 [110/1563] via 172.16.23.3, 00:00:45, Serial0/0/1
     192.168.40.0/32 is subnetted, 1 subnets
O       192.168.40.1 [110/1563] via 172.16.23.3, 00:00:45, Serial0/0/1
R2#
```

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g. Verify that your adjacencies and routing table of R3.

```
R3# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address
Interface
172.16.100.1      0   FULL/  -        00:00:39    172.16.23.2
Serial0/0/1
R3#
R3# show ip route ospf

<Output omitted>

      172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
O IA     172.16.100.0/24 [110/1563] via 172.16.23.2, 00:07:02,
Serial0/0/1
R3#
```

```
R3#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
172.16.100.1      0   FULL/  -        00:00:35    172.16.23.2     Serial0/0/1
R3#show ip route ospf
     172.16.0.0/16 is variably subnetted, 5 subnets, 2 masks
O IA    172.16.100.0 [110/1563] via 172.16.23.2, 00:01:47, Serial0/0/1
R3#
```

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h. Verify that R1 and R2 can reach all of the networks in the OSPF routing domain using the following Tcl script.

```
R1# tclsh

foreach address {
172.16.100.1
172.16.23.2
172.16.23.3
172.16.3.1
192.168.8.1
192.168.9.1
192.168.10.1
192.168.11.1
192.168.20.1
192.168.25.1
192.168.30.1
192.168.35.1
192.168.40.1
} { ping $address }
```

All pings should be successful. Troubleshoot if necessary.

Step 5: Summarize OSPF areas at the ABR.

Review the R2 routing table. Notice the inter-area routes (O IA) for the R3 loopbacks in area 20.

Where can you summarize in OSPF?

RTA: En OSPF, puede resumir en el enrutador de frontera de área (ABR) y el enrutador de frontera del sistema autónomo (ASBR). Los LSAs inter-área de resumen creados en el ABR están incorporados en los LSA tipo 3. Resumen externo Los LSA creados en la ASBR están integrados en los LSA de Tipo 5

a. These four routes can be summarized into a single inter-area route using the **area** *area* **range** *network mask* command on the ABR, R3.

```
R3(config)# router ospf 1
R3(config-router)# area 20 range 192.168.8.0 255.255.252.0
```

b. On R2, verify the summarization with the **show ip route ospf** command on R2.

```
R2#show ip route ospf

<Output omitted>

      172.16.0.0/16 is variably subnetted, 10 subnets, 2 masks
O        172.16.3.0/24 [110/1563] via 172.16.23.3, 00:37:42,
Serial0/0/1
O IA  192.168.8.0/22 [110/1563] via 172.16.23.3, 00:01:26,
Serial0/0/1
O     192.168.20.0/24 [110/1563] via 172.16.23.3, 00:37:42,
Serial0/0/1
```

```
O     192.168.25.0/24 [110/1563] via 172.16.23.3, 00:37:42,
Serial0/0/1
O     192.168.30.0/24 [110/1563] via 172.16.23.3, 00:37:42,
Serial0/0/1
O     192.168.35.0/24 [110/1563] via 172.16.23.3, 00:37:42,
Serial0/0/1
O     192.168.40.0/24 [110/1563] via 172.16.23.3, 00:37:42,
Serial0/0/1
R2#
```

```
R2(config)#router ospf 1
R2(config-router)#redistribute eigrp 1 subnets
R2(config-router)#exit
R2(config)#router eigrp 1
R2(config-router)#redistribute ospf 1 metric 10000 100 255 1 1500
R2(config-router)#exit
R2(config)#router eigrp 1
R2(config-router)#default-metric 10000 100 255 1 1500
                   ^
% Invalid input detected at '^' marker.

R2(config-router)#
```

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Compare and contrast OSPF and EIGRP in terms of where summarization takes place.

RTA: EIGRP permite el resumen en cualquier interfaz EIGRP router en el dominio. OSPF puede resumirse sólo en el ABR y el ASBR.

Step 6: Configure mutual redistribution between OSPF and EIGRP.

Notice that R2 is the only router with knowledge of all routes (EIGRP and OSPF) in the topology at this point, because it is involved with both routing protocols. Next you will redistribute the EIGRP routes into OSPF and the OSPF routes into EIGRP.

a. To redistribute the EIGRP routes into OSPF, on R2 issue the **redistribute eigrp 1 subnets** command. The **subnets** command is necessary because, by default, OSPF only redistributes classful networks and supernets.

```
R2(config)# router ospf 1
R2(config-router)# redistribute eigrp 1 subnets
R2(config-router)# exit
```

A default seed metric is not required for OSPF. Redistributed routes are assigned a metric of 20 by default.

b. To redistribute the OSPF routes into EIGRP, on R2 issue the **redistribute ospf 1 metric 10000 100 255 1 1500** command. Unlike OSPF, EIGRP must specify the metric associated to the redistributed routes. The command tells EIGRP to redistribute OSPF process 1 with these metrics: bandwidth of 10000, delay of 100, reliability of 255/255, load of 1/255, and a MTU of 1500. EIGRP requires a seed metric.

```
R2(config)# router eigrp 1
R2(config-router)# redistribute ospf 1 metric 10000 100 255 1 1500
R2(config-router)# exit
```

Alternatively, you can also set a default seed metric with the **default-metric** command.

```
R2(config-router)# default-metric 10000 100 255 1 1500
R2(config-router)# redistribute ospf 1
```

```
R2(config-router)# end
```

c. Issue the **show ip protocols** command on the redistributing router, R2. Compare your output with the following output.

```
R2# show ip protocols
*** IP Routing is NSF aware ***

<Output omitted>

Routing Protocol is "eigrp 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  Redistributing: ospf 1
  EIGRP-IPv4 Protocol for AS(1)
    Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
    NSF-aware route hold timer is 240
    Router-ID: 172.16.100.1
    Topology : 0 (base)
      Active Timer: 3 min
      Distance: internal 90 external 170
      Maximum path: 4
      Maximum hopcount 100
      Maximum metric variance 1

  Automatic Summarization: disabled
  Maximum path: 4
  Routing for Networks:
    172.16.0.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    172.16.12.1           90      02:00:24
  Distance: internal 90 external 170

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 172.16.100.1
  It is an area border and autonomous system boundary router
 Redistributing External Routes from,
    eigrp 1, includes subnets in redistribution
  Number of areas in this router is 2. 2 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    172.16.23.0 0.0.0.255 area 0
    172.16.100.0 0.0.0.255 area 10
  Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.40.1         110      00:37:06
```

```
  Distance: (default is 110)

R2#
```

d. Display the routing table on R1 to verify the redistributed routes. Redistributed OSPF routes display on R1 as D EX, which means that they are external EIGRP routes.

```
R1# show ip route

<Output omitted>

Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
C        172.16.1.0/24 is directly connected, Loopback0
L        172.16.1.1/32 is directly connected, Loopback0
D        172.16.2.0/24 [90/40640000] via 172.16.12.2, 02:08:18,
Serial0/0/0
D EX     172.16.3.0/24 [170/40537600] via 172.16.12.2, 00:04:41,
Serial0/0/0
C        172.16.12.0/24 is directly connected, Serial0/0/0
L        172.16.12.1/32 is directly connected, Serial0/0/0
D        172.16.23.0/24 [90/41024000] via 172.16.12.2, 02:08:18,
Serial0/0/0
D        172.16.100.0/24 [90/40640000] via 172.16.12.2, 02:08:18,
Serial0/0/0
D EX  192.168.8.0/22 [170/40537600] via 172.16.12.2, 00:04:41,
Serial0/0/0
D EX  192.168.20.0/24 [170/40537600] via 172.16.12.2, 00:04:41,
Serial0/0/0
D EX  192.168.25.0/24 [170/40537600] via 172.16.12.2, 00:04:41,
Serial0/0/0
D EX  192.168.30.0/24 [170/40537600] via 172.16.12.2, 00:04:41,
Serial0/0/0
D EX  192.168.35.0/24 [170/40537600] via 172.16.12.2, 00:04:41,
Serial0/0/0
D EX  192.168.40.0/24 [170/40537600] via 172.16.12.2, 00:04:41,
Serial0/0/0
D     192.168.48.0/23 is a summary, 02:04:14, Null0
      192.168.48.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.48.0/24 is directly connected, Loopback48
L        192.168.48.1/32 is directly connected, Loopback48
      192.168.49.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.49.0/24 is directly connected, Loopback49
L        192.168.49.1/32 is directly connected, Loopback49
      192.168.50.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.50.0/24 is directly connected, Loopback50
L        192.168.50.1/32 is directly connected, Loopback50
      192.168.51.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.51.0/24 is directly connected, Loopback51
```

```
L          192.168.51.1/32 is directly connected, Loopback51
        192.168.70.0/24 is variably subnetted, 2 subnets, 2 masks
C          192.168.70.0/24 is directly connected, Loopback70
L          192.168.70.1/32 is directly connected, Loopback70
R1#
```

```
C        172.16.12.0/24 is directly connected, Serial0/0/0
L        172.16.12.1/32 is directly connected, Serial0/0/0
D        172.16.23.0/24 [90/41024000] via 172.16.12.2, 00:09:41, Serial0/0/0
D        172.16.100.0/24 [90/40640000] via 172.16.12.2, 00:08:05, Serial0/0/0
      192.168.8.0/32 is subnetted, 1 subnets
D EX     192.168.8.1/32 [170/40537600] via 172.16.12.2, 00:01:06, Serial0/0/0
      192.168.9.0/32 is subnetted, 1 subnets
D EX     192.168.9.1/32 [170/40537600] via 172.16.12.2, 00:01:06, Serial0/0/0
      192.168.10.0/32 is subnetted, 1 subnets
D EX     192.168.10.1/32 [170/40537600] via 172.16.12.2, 00:01:06, Serial0/0/0
      192.168.11.0/32 is subnetted, 1 subnets
D EX     192.168.11.1/32 [170/40537600] via 172.16.12.2, 00:01:06, Serial0/0/0
      192.168.20.0/32 is subnetted, 1 subnets
D EX     192.168.20.1/32 [170/40537600] via 172.16.12.2, 00:01:06, Serial0/0/0
      192.168.25.0/32 is subnetted, 1 subnets
D EX     192.168.25.1/32 [170/40537600] via 172.16.12.2, 00:01:06, Serial0/0/0
      192.168.30.0/32 is subnetted, 1 subnets
D EX     192.168.30.1/32 [170/40537600] via 172.16.12.2, 00:01:06, Serial0/0/0
      192.168.35.0/32 is subnetted, 1 subnets
D EX     192.168.35.1/32 [170/40537600] via 172.16.12.2, 00:01:06, Serial0/0/0
      192.168.40.0/32 is subnetted, 1 subnets
D EX     192.168.40.1/32 [170/40537600] via 172.16.12.2, 00:01:06, Serial0/0/0
D     192.168.48.0/23 is a summary, 00:09:44, Null0
```

e. Display the routing table on R3 to see the redistributed routes. Redistributed EIGRP routes are tagged in the R3 routing table as O E2, which means that they are OSPF external type 2. Type 2 is the default OSPF external type.

```
R3# show ip route

<Output omitted>



Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
O E2     172.16.1.0/24 [110/20] via 172.16.23.2, 00:08:18,
Serial0/0/1
O E2     172.16.2.0/24 [110/20] via 172.16.23.2, 00:08:18,
Serial0/0/1
C        172.16.3.0/24 is directly connected, Loopback0
L        172.16.3.1/32 is directly connected, Loopback0
O E2     172.16.12.0/24 [110/20] via 172.16.23.2, 00:08:18,
Serial0/0/1
C        172.16.23.0/24 is directly connected, Serial0/0/1
L        172.16.23.3/32 is directly connected, Serial0/0/1
O IA     172.16.100.0/24 [110/1563] via 172.16.23.2, 00:43:53,
Serial0/0/1
O     192.168.8.0/22 is a summary, 00:43:53, Null0
      192.168.8.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.8.0/24 is directly connected, Loopback8
L        192.168.8.1/32 is directly connected, Loopback8
      192.168.9.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.9.0/24 is directly connected, Loopback9
L        192.168.9.1/32 is directly connected, Loopback9
      192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.10.0/24 is directly connected, Loopback10
L        192.168.10.1/32 is directly connected, Loopback10
      192.168.11.0/24 is variably subnetted, 2 subnets, 2 masks
```

```
C        192.168.11.0/24 is directly connected, Loopback11
L        192.168.11.1/32 is directly connected, Loopback11
      192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.20.0/24 is directly connected, Loopback20
L        192.168.20.1/32 is directly connected, Loopback20
      192.168.25.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.25.0/24 is directly connected, Loopback25
L        192.168.25.1/32 is directly connected, Loopback25
      192.168.30.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.30.0/24 is directly connected, Loopback30
L        192.168.30.1/32 is directly connected, Loopback30
      192.168.35.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.35.0/24 is directly connected, Loopback35
L        192.168.35.1/32 is directly connected, Loopback35
      192.168.40.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.40.0/24 is directly connected, Loopback40
L        192.168.40.1/32 is directly connected, Loopback40
O E2  192.168.48.0/23 [110/20] via 172.16.23.2, 00:08:18,
Serial0/0/1
O E2  192.168.50.0/24 [110/20] via 172.16.23.2, 00:08:18,
Serial0/0/1
O E2  192.168.51.0/24 [110/20] via 172.16.23.2, 00:08:18,
Serial0/0/1
O E2  192.168.70.0/24 [110/20] via 172.16.23.2, 00:08:18,
Serial0/0/1
R3#
```

f. Verify full connectivity with the following Tcl script:

```
R1# tclsh

foreach address {
172.16.1.1
192.168.48.1
192.168.49.1
192.168.50.1
192.168.51.1
192.168.70.1
172.16.12.1
172.16.12.2
172.16.2.1
172.16.100.1
172.16.23.2
172.16.23.3
172.16.3.1
192.168.8.1
192.168.9.1
192.168.10.1
192.168.11.1
192.168.20.1
192.168.25.1
192.168.30.1
192.168.35.1
192.168.40.1
} { ping $address }
```

All pings should now be successful. Troubleshoot as necessary

Step 7: Summarize external routes into OSPF at the ASBR.

You cannot summarize routes redistributed into OSPF using the **area range** command. This command is effective only on routes internal to the specified area. Instead, use the OSPF **summary-address** *network mask* command.

a. Before you make any changes, display the R3 the OSPF routes in the routing table and list only those routes that have a E2 type metric.

```
R3# show ip route ospf | include E2
       E1 - OSPF external type 1, E2 - OSPF external type 2
O E2     172.16.1.0/24 [110/20] via 172.16.23.2, 00:16:22,
Serial0/0/1
O E2     172.16.2.0/24 [110/20] via 172.16.23.2, 00:16:22,
Serial0/0/1
O E2     172.16.12.0/24 [110/20] via 172.16.23.2, 00:16:22,
Serial0/0/1
O E2  192.168.48.0/23 [110/20] via 172.16.23.2, 00:16:22,
Serial0/0/1
O E2  192.168.50.0/24 [110/20] via 172.16.23.2, 00:16:22,
Serial0/0/1
O E2  192.168.51.0/24 [110/20] via 172.16.23.2, 00:16:22,
Serial0/0/1
O E2  192.168.70.0/24 [110/20] via 172.16.23.2, 00:16:22,
Serial0/0/1
R3#
```

Notice the external routes for the R1 loopback interfaces 48, 50 and 51. Loopbacks 48 and 49 were previously summarized in EIGRP, they will be included when redistributing the EIGRP into OSPF.

Which mask should you use to summarize all loopbacks 48, 50, and 51 to one prefix?

RTA: Utilice la máscara de 22 bits con la dirección de red 192.168.48.0.

b. You can summarize this all into one supernet on R2 using the following commands.

```
R2(config)# router ospf 1
R2(config-router)# summary-address 192.168.48.0 255.255.252.0
R2(config-router)#
```

c. Verify this action in the R3 routing table.

```
R3# show ip route ospf | include E2
       E1 - OSPF external type 1, E2 - OSPF external type 2
O E2     172.16.1.0/24 [110/20] via 172.16.23.2, 00:21:44,
Serial0/0/1
O E2     172.16.2.0/24 [110/20] via 172.16.23.2, 00:21:44,
Serial0/0/1
O E2     172.16.12.0/24 [110/20] via 172.16.23.2, 00:21:44,
Serial0/0/1
O E2  192.168.48.0/22 [110/20] via 172.16.23.2, 00:00:07,
Serial0/0/1
O E2  192.168.70.0/24 [110/20] via 172.16.23.2, 00:21:44,
Serial0/0/1
R3#
```

What would happen if loopback 50 on R1 were to become unreachable by R2?

RTA: R2 aún anunciaría la dirección de resumen de 22 bits a R3 hasta que todas las subredes incluidas en el resumen se vuelvan inaccesibles.

Would data destined for 192.168.50.0/24 from R3 still be sent to R2?

RTA: Sí. Los paquetes de datos destinados a 192.168.50.0/24 de R3 seguirán siendo enviados a R2.

Would data destined for 192.168.50.0/24 from R2 continue to be sent to R1?

RTA: No. Debido a que R2 no tiene prefijos de más de 22 bits que coinciden con la subred 192.168.50.0/24, los paquetes serán enrutados a la interfaz virtual Null0 en R2.

d. If you are unsure of the outcome, shut down the interface on R1. Issue the ICMP **traceroute** command to 192.168.50.1 from R3 and then from R2. Check your output against the output and analysis in Appendix A. Remember to issue the **no shutdown** command when you are finished checking.

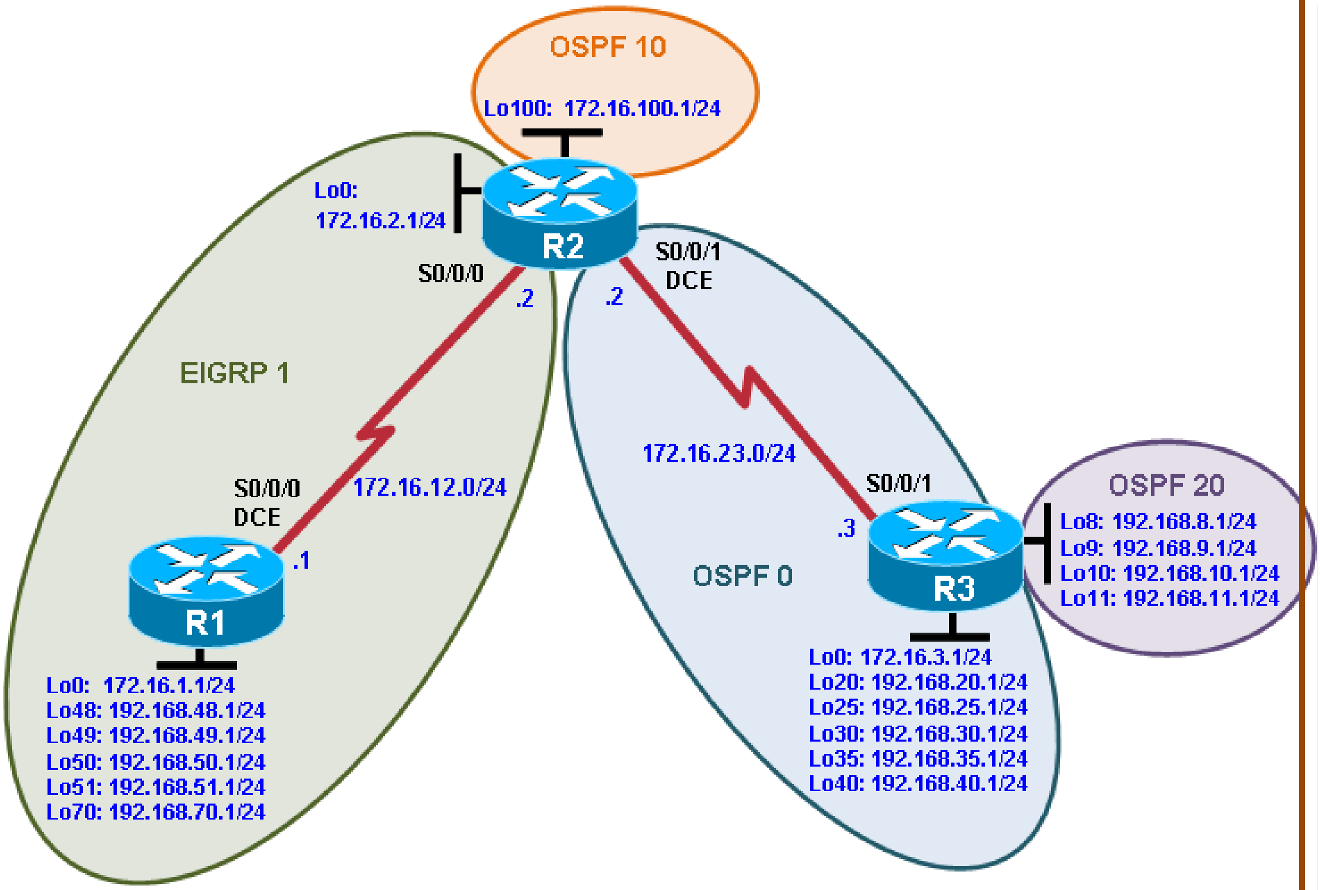
Is this a desirable outcome? Explain.

RTA: Es un resultado deseable porque el resumen permite que las tablas de enrutamiento se reduzcan en tamaño. Sin embargo, un resultado que a veces puede considerarse poco indeseable es que el tráfico de datos se reenvía más allá de donde sería enviado sin resumen.

The resulting configuration is required for Lab 4-2.

Lab 4-2, Controlling Routing Updates

Topology



Objectives

- Filter routes using a distribute list and ACL.
- Filter routes using a distribute list and prefix list.
- Filter redistributed routes using a route map.
- Filter redistributed routes and set attributes using a route map.

Background

In this scenario, R1 and R2 are running EIGRP while R2 and R3 are running multi-area OSPF. R2 is the OSPF autonomous system border router (ASBR) consisting of areas 0, 10, and 20.
Your task is to control routing updates by using distribute lists, prefix lists and route maps.

Note: This lab uses Cisco 1941 routers with Cisco IOS Release 15.2 with IP Base. Depending on the router or switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 3 routers (Cisco IOS Release 15.2 or comparable)
- Serial and Ethernet cables

Step 1: Configure loopbacks and assign addresses.

Note: The following two steps are not required if you are continuing from Lab 4-1.

a. Configure all loopback interfaces on the three routers in the diagram. Configure the serial interfaces with the IP addresses, bring them up, and set a DCE clock rate where appropriate.

```
R1(config)# interface Loopback0
R1(config-if)# ip address 172.16.1.1 255.255.255.0
R1(config-if)# exit
R1(config)#
R1(config)# interface Loopback48
```

```
R1(config-if)# ip address 192.168.48.1 255.255.255.0
R1(config-if)# exit
R1(config)#
R1(config)# interface Loopback49
R1(config-if)# ip address 192.168.49.1 255.255.255.0
R1(config-if)# exit
R1(config)#
R1(config)# interface Loopback50
R1(config-if)# ip address 192.168.50.1 255.255.255.0
R1(config-if)# exit
R1(config)#
R1(config)# interface Loopback51
R1(config-if)# ip address 192.168.51.1 255.255.255.0
R1(config-if)# exit
R1(config)#
R1(config)# interface Loopback70
R1(config-if)# ip address 192.168.70.1 255.255.255.0
R1(config-if)# exit
R1(config)#
R1(config)# interface Serial0/0/0
R1(config-if)# ip address 172.16.12.1 255.255.255.0
R1(config-if)# clock rate 64000
R1(config-if)# bandwidth 64
R1(config-if)# no shutdown

R2(config)# interface Loopback0
R2(config-if)# ip address 172.16.2.1 255.255.255.0
R2(config-if)# exit
R2(config)#
R2(config)# interface Loopback100
R2(config-if)# ip address 172.16.100.1 255.255.255.0
R2(config-if)# ip ospf network point-to-point
R2(config-if)# exit
R2(config)#
R2(config-if)# interface Serial0/0/0
R2(config-if)# bandwidth 64
R2(config-if)# ip address 172.16.12.2 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)#
R2(config)# interface Serial0/0/1
R2(config-if)# bandwidth 64
R2(config-if)# ip address 172.16.23.2 255.255.255.0
R2(config-if)# clock rate 64000
R2(config-if)# no shutdown

R3(config)# interface Loopback0
R3(config-if)# ip address 172.16.3.1 255.255.255.0
R3(config-if)# ip ospf network point-to-point
R3(config-if)# exit
R3(config)#
R3(config)# interface loopback 8
R3(config-if)# ip address 192.168.8.1 255.255.255.0
R3(config-if)# ip ospf network point-to-point
R3(config-if)# exit
R3(config)#
R3(config)# interface loopback 9
R3(config-if)# ip address 192.168.9.1 255.255.255.0
R3(config-if)# ip ospf network point-to-point
R3(config-if)# exit
R3(config)#
```

```
R3(config)# interface loopback 10
R3(config-if)# ip address 192.168.10.1 255.255.255.0
R3(config-if)# ip ospf network point-to-point
R3(config-if)# exit
R3(config)#
R3(config)# interface loopback 11
R3(config-if)# ip address 192.168.11.1 255.255.255.0
R3(config-if)# ip ospf network point-to-point
R3(config-if)# exit
R3(config)#
R3(config)# interface Loopback20
R3(config-if)# ip address 192.168.20.1 255.255.255.0
R3(config-if)# ip ospf network point-to-point
R3(config-if)# exit
R3(config)#
R3(config)# interface Loopback25
R3(config-if)# ip address 192.168.25.1 255.255.255.0
R3(config-if)# ip ospf network point-to-point
R3(config-if)# exit
R3(config)#
R3(config)# interface Loopback30
R3(config-if)# ip address 192.168.30.1 255.255.255.0
R3(config-if)# ip ospf network point-to-point
R3(config-if)# exit
R3(config)#
R3(config)# interface Loopback35
R3(config-if)# ip address 192.168.35.1 255.255.255.0
R3(config-if)# ip ospf network point-to-point
R3(config-if)# exit
R3(config)#
R3(config)# interface Loopback40
R3(config-if)# ip address 192.168.40.1 255.255.255.0
R3(config-if)# ip ospf network point-to-point
R3(config-if)# exit
R3(config)#
R3(config)# interface Serial0/0/1
R3(config-if)# ip address 172.16.23.3 255.255.255.0
R3(config-if)# bandwidth 64
R3(config-if)# no shutdown
```

```
R2(config)#interface Loopback100

R2(config-if)#
%LINK-5-CHANGED: Interface Loopback100, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback100, changed state to up

R2(config-if)#ip address 172.16.100.1 255.255.255.0
R2(config-if)#exit
R2(config)#interface Serial0/0/0
R2(config-if)#ip address 172.16.12.2 255.255.255.0
R2(config-if)#bandwidth 64
R2(config-if)#no shutdown

R2(config-if)#
%LINK-5-CHANGED: Interface Serial0/0/0, changed state to up

R2(config-if)#interface Serial0/0/1
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up

R2(config-if)#ip address 172.16.23.2 255.255.255.0
R2(config-if)#clock rate 64000
R2(config-if)#bandwidth 64
R2(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0/1, changed state to down
R2(config-if)#
```

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Step 2: Configure Routing, Summarization, and Redistribution.

In this step, we will configure EIGRP on R1 and R2, and OSPF on R2 and R3.

a. On R1, create a supernet route summarizing the loopback 48 and 49 networks and configure EIGRP in autonomous system 1.

```
R1(config)# interface Serial0/0/0
R1(config-if)# ip summary-address eigrp 1 192.168.48.0 255.255.254.0
R1(config-if)# exit
R1(config)# router eigrp 1
R1(config-router)# no auto-summary
R1(config-router)# network 172.16.0.0
R1(config-router)# network 192.168.0.0 0.0.255.255
R1(config-router)#
```

```
R1(config)#router eigrp 1
R1(config-router)#no auto-summary
R1(config-router)#network 172.16.0.0
R1(config-router)#network 192.168.48.0
R1(config-router)#network 192.168.49.0
R1(config-router)#network 192.168.50.0
R1(config-router)#network 192.168.51.0
R1(config-router)#network 192.168.70.0
R1(config-router)#
```

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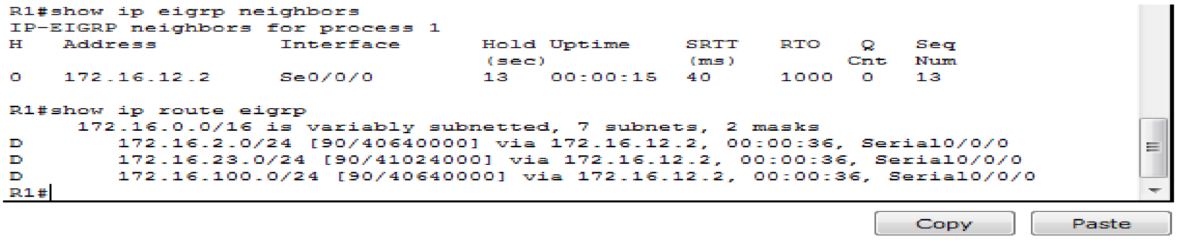
b. On R3, summarize area 20 routes and configure OSPF for area 0 and area 20.

```
R3(config)# router ospf 1
R3(config-router)# area 20 range 192.168.8.0 255.255.252.0
R3(config-router)# network 172.16.0.0 0.0.255.255 area 0
R3(config-router)# network 192.168.0.0 0.0.255.255 area 0
R3(config-router)# network 192.168.8.0 0.0.3.255 area 20
```

```
R3(config-router)#
```

c. On R2, configure EIGRP and redistribute the OSPF networks into EIGRP AS 1. Then configure OSPF and redistribute and summarize the EIGRP networks into OSPF.

```
R2(config)# router eigrp 1
R2(config-router)# no auto-summary
R2(config-router)# network 172.16.0.0
R2(config-router)# redistribute ospf 1 metric 10000 100 255 1 1500
R2(config-router)# exit
R2(config)#
R2(config)# router ospf 1
R2(config-router)# network 172.16.23.0 0.0.0.255 area 0
R2(config-router)# network 172.16.100.0 0.0.0.255 area 10
R2(config-router)# redistribute eigrp 1 subnets
R2(config-router)# summary-address 192.168.48.0 255.255.252.0
R2(config-router)# exit
R2(config)#
Jan 10 10:11:18.863: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1: Neighbor
172.16.12.1 (Serial0/0/0) is up: new adjacency
R2(config)#
Jan 10 10:11:32.991: %OSPF-5-ADJCHG: Process 1, Nbr 192.168.40.1 on
Serial0/0/1 from LOADING to FULL, Loading Done
R2(config)#
```



```
R1#show ip eigrp neighbors
IP-EIGRP neighbors for process 1
H   Address         Interface      Hold Uptime    SRTT   RTO   Q   Seq
                                   (sec)          (ms)         Cnt Num
0   172.16.12.2     Se0/0/0        13   00:00:15  40     1000  0   13

R1#show ip route eigrp
     172.16.0.0/16 is variably subnetted, 7 subnets, 2 masks
D       172.16.2.0/24 [90/40640000] via 172.16.12.2, 00:00:36, Serial0/0/0
D       172.16.23.0/24 [90/41024000] via 172.16.12.2, 00:00:36, Serial0/0/0
D       172.16.100.0/24 [90/40640000] via 172.16.12.2, 00:00:36, Serial0/0/0
R1#
```


d. Verify the EIGRP and OSPF routing table entries on R2.

```
R2# show ip route eigrp | begin Gateway
Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 10 subnets, 2 masks
D        172.16.1.0/24 [90/40640000] via 172.16.12.1, 00:14:57,
Serial0/0/0
D     192.168.48.0/23 [90/40640000] via 172.16.12.1, 00:14:57,
Serial0/0/0
D     192.168.50.0/24 [90/40640000] via 172.16.12.1, 00:14:57,
Serial0/0/0
D     192.168.51.0/24 [90/40640000] via 172.16.12.1, 00:14:57,
Serial0/0/0
D     192.168.70.0/24 [90/40640000] via 172.16.12.1, 00:14:57,
Serial0/0/0
R2#
R2# show ip route ospf | begin Gateway
Gateway of last resort is not set
```

```
      172.16.0.0/16 is variably subnetted, 10 subnets, 2 masks
O        172.16.3.0/24 [110/1563] via 172.16.23.3, 00:15:41,
Serial0/0/1
O IA  192.168.8.0/22 [110/1563] via 172.16.23.3, 00:15:41,
Serial0/0/1
O     192.168.20.0/24 [110/1563] via 172.16.23.3, 00:15:41,
Serial0/0/1
O     192.168.25.0/24 [110/1563] via 172.16.23.3, 00:15:41,
Serial0/0/1
O     192.168.30.0/24 [110/1563] via 172.16.23.3, 00:15:41,
Serial0/0/1
O     192.168.35.0/24 [110/1563] via 172.16.23.3, 00:15:41,
Serial0/0/1
O     192.168.40.0/24 [110/1563] via 172.16.23.3, 00:15:41,
Serial0/0/1
O     192.168.48.0/22 is a summary, 00:15:30, Null0
R2#
```

As expected, R2 knows about the R1 routes including the summarized 192.168.48.0/22 EIGRP route. R2 also knows about the R3 OSPF area 0 routes and the summarized area 20 routes.

e. Verify the EIGRP routing table on R1.

```
R1# show ip route eigrp | begin Gateway
Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
D        172.16.2.0/24 [90/40640000] via 172.16.12.2, 00:11:40,
Serial0/0/0
D EX     172.16.3.0/24 [170/40537600] via 172.16.12.2, 00:11:40,
Serial0/0/0
D        172.16.23.0/24 [90/41024000] via 172.16.12.2, 00:11:40,
Serial0/0/0
D        172.16.100.0/24 [90/40640000] via 172.16.12.2, 00:11:40,
Serial0/0/0
D EX  192.168.8.0/22 [170/40537600] via 172.16.12.2, 00:11:40,
Serial0/0/0
D EX  192.168.20.0/24 [170/40537600] via 172.16.12.2, 00:11:40,
Serial0/0/0
D EX  192.168.25.0/24 [170/40537600] via 172.16.12.2, 00:11:40,
Serial0/0/0
D EX  192.168.30.0/24 [170/40537600] via 172.16.12.2, 00:11:40,
Serial0/0/0
D EX  192.168.35.0/24 [170/40537600] via 172.16.12.2, 00:11:40,
Serial0/0/0
D EX  192.168.40.0/24 [170/40537600] via 172.16.12.2, 00:11:40,
Serial0/0/0
```

```
D EX  192.168.48.0/22 [170/40537600] via 172.16.12.2, 00:11:38,
Serial0/0/0
D     192.168.48.0/23 is a summary, 00:11:40, Null0
R1#
```

R1 knows about the internal EIGRP routes and the external routes redistributed from the OSPF routing domain by R2. The highlighted entry identifies the OSPF 20 routes which will be filtered using a distribute list and ACL in the next step.

f. Verify the EIGRP routing table on R3.

```
R3# show ip route ospf | begin Gateway
Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
O E2     172.16.1.0/24 [110/20] via 172.16.23.2, 00:22:43,
Serial0/0/1
O E2     172.16.2.0/24 [110/20] via 172.16.23.2, 00:22:52,
Serial0/0/1
O E2     172.16.12.0/24 [110/20] via 172.16.23.2, 00:22:52,
Serial0/0/1
O IA     172.16.100.0/24 [110/1563] via 172.16.23.2, 00:22:52,
Serial0/0/1
O     192.168.8.0/22 is a summary, 00:23:10, Null0
O E2  192.168.48.0/22 [110/20] via 172.16.23.2, 00:22:41,
Serial0/0/1
O E2  192.168.70.0/24 [110/20] via 172.16.23.2, 00:22:42,
Serial0/0/1
R3#
```

R3 knows about the internal OSPF routes and the external routes redistributed by R2 from the EIGRP routing domain. The highlighted entries identify the EIGRP routes which will be filtered using a distribute list and prefix list in another step.

g. Verify that you can ping across the serial links when you are finished. Use the following Tcl script to check connectivity.

```
R3# tclsh

foreach address {
172.16.1.1
192.168.48.1
192.168.49.1
192.168.50.1
192.168.51.1
192.168.70.1
172.16.12.1
172.16.12.2
172.16.2.1
172.16.100.1
172.16.23.2
172.16.23.3
172.16.3.1
192.168.8.1
192.168.9.1
192.168.10.1
192.168.11.1
```

```
192.168.20.1
192.168.25.1
192.168.30.1
192.168.35.1
192.168.40.1
} { ping $address }
```

All pings should be successful. Troubleshoot if necessary.

Step 3: Filter redistributed routes using a distribute list and ACL.

Routes can be filtered using a variety of techniques including:

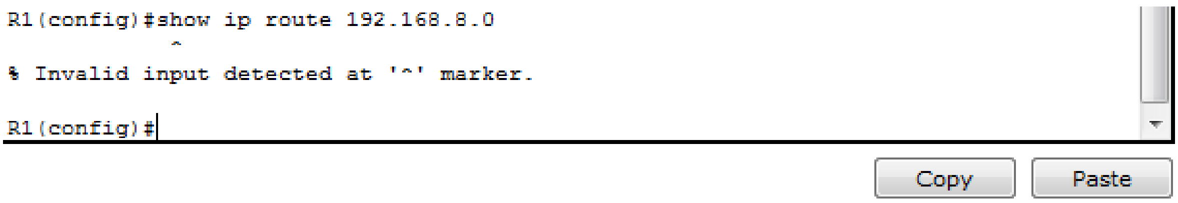
Distribute list and ACL— A distribute list allows an access control lists (ACLs) to be applied to routing updates.

- **Distribute list and prefix list**— A distribute list with a prefix list is an alternative to ACLs designed to filter routes. Prefix lists are not exclusively used with distribute lists but can also be used with route maps and other commands.
- **Route maps**— Route maps are complex access lists that allow conditions to be tested against a packet or route, and then actions taken to modify attributes of the packet or route.

In this step, we will use a distribute list and ACL to filter routes being advertised from R2 to R1. Specifically, we will filter the OSPF 20 routes (i.e., 192.168.8.0/22) from being advertised by R2 to R1.

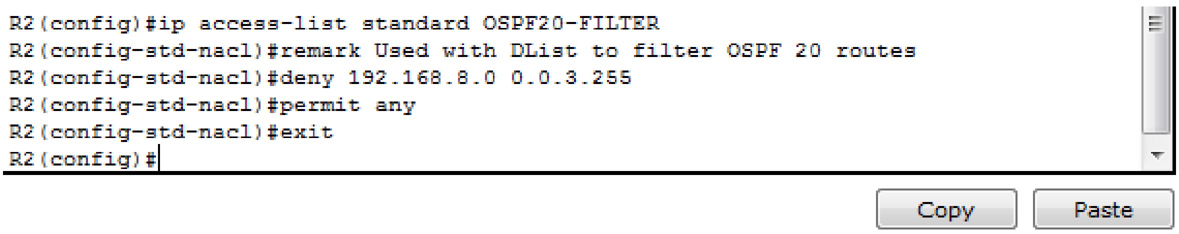
a. On R1, verify the routing table entry for the 192.168.8.0/22 route.

```
R1# show ip route 192.168.8.0
Routing entry for 192.168.8.0/22, supernet
  Known via "eigrp 1", distance 170, metric 40537600, type external
  Redistributing via eigrp 1
  Last update from 172.16.12.2 on Serial0/0/0, 00:00:43 ago
  Routing Descriptor Blocks:
  * 172.16.12.2, from 172.16.12.2, 00:00:43 ago, via Serial0/0/0
      Route metric is 40537600, traffic share count is 1
      Total delay is 21000 microseconds, minimum bandwidth is 64 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 1
R1#
```



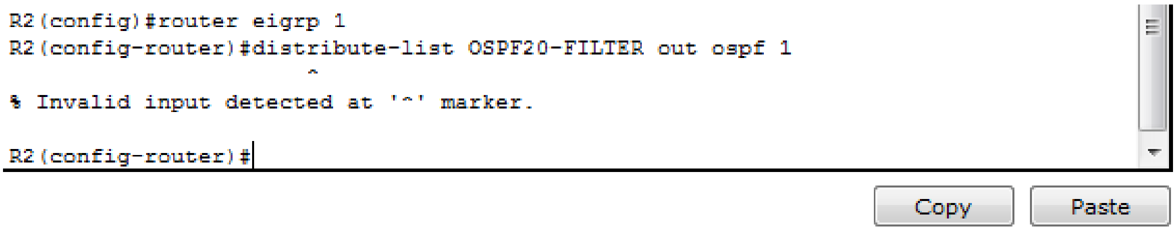
b. Although a distribute list could be implemented on the receiving router, it is usually best to filter routes from the distributing router. Therefore on R2, create an ACL called **OSPF20-FILTER** that denies the 192.168.8.0/22 route. The ACL must also permit all other routes otherwise, no OSPF routes would be redistributed into EIGRP.

```
R2(config)# ip access-list standard OSPF20-FILTER
R2(config-std-nacl)# remark Used with DList to filter OSPF 20 routes
R2(config-std-nacl)# deny 192.168.8.0 0.0.3.255
R2(config-std-nacl)# permit any
R2(config-std-nacl)# exit
R2(config)#
```



c. Configure a distribute list under the EIGRP process to filter routes propagated to R1 using the pre-configured ACL.

```
R2(config)# router eigrp 1
R2(config-router)# distribute-list OSPF20-FILTER out ospf 1
R2(config-router)#
```



```
R2(config)#router eigrp 1
R2(config-router)#distribute-list OSPF20-FILTER out ospf 1
                                 ^
% Invalid input detected at '^' marker.

R2(config-router)#
```


d. On R1, verify if the route is now missing from the R1 routing table.

```
R1# show ip route 192.168.8.0
% Network not in table
R1#
R1# show ip route eigrp | begin Gateway
Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
D        172.16.2.0/24 [90/40640000] via 172.16.12.2, 00:00:03, Serial0/0/0
D EX     172.16.3.0/24 [170/40537600] via 172.16.12.2, 00:00:03,
Serial0/0/0
D        172.16.23.0/24 [90/41024000] via 172.16.12.2, 00:00:03,
Serial0/0/0
D        172.16.100.0/24 [90/40640000] via 172.16.12.2, 00:00:03,
Serial0/0/0
D EX  192.168.20.0/24 [170/40537600] via 172.16.12.2, 00:00:03, Serial0/0/0
D EX  192.168.25.0/24 [170/40537600] via 172.16.12.2, 00:00:03, Serial0/0/0
D EX  192.168.30.0/24 [170/40537600] via 172.16.12.2, 00:00:03, Serial0/0/0
D EX  192.168.35.0/24 [170/40537600] via 172.16.12.2, 00:00:03, Serial0/0/0
D EX  192.168.40.0/24 [170/40537600] via 172.16.12.2, 00:00:03, Serial0/0/0
D EX  192.168.48.0/22 [170/40537600] via 172.16.12.2, 00:00:03, Serial0/0/0
D     192.168.48.0/23 is a summary, 00:00:03, Null0
R1#
```

The output confirms that the 192.168.8.0/22 route is no longer in the routing table of R1.
Note that if additional router filtering was required, only the ACL on R2 would need to be altered.

Step 4: Filter redistributed routes using a distribute list and prefix list.

In this step, a prefix list will be configured with a distribute list to filter R1 routes being advertised from R2 to R3.

a. On R3, verify the routing table entry for the routes learned externally identified with the 0 E2 source entry.

```
R3# show ip route ospf | include O E2
O E2     172.16.1.0/24 [110/20] via 172.16.23.2, 00:10:12, Serial0/0/1
O E2     172.16.2.0/24 [110/20] via 172.16.23.2, 00:10:12, Serial0/0/1
O E2     172.16.12.0/24 [110/20] via 172.16.23.2, 00:10:12, Serial0/0/1
O E2  192.168.48.0/22 [110/20] via 172.16.23.2, 00:02:05, Serial0/0/1
O E2  192.168.70.0/24 [110/20] via 172.16.23.2, 00:02:05, Serial0/0/1
R3#
```

Specifically, the highlighted routes will be omitted from being advertised using a prefix list.

b. R2 will be configured with a prefix list identifying which networks to advertise to advertise to R3. Specifically, only the 172.16.0.0 networks are permitted.

```
R2(config)# ip prefix-list EIGRP-FILTER description Used with DList to
filter EIGRP routes
R2(config)# ip prefix-list EIGRP-FILTER permit 172.16.0.0/16 le 24
R2(config)#
```

c. Configure a distribute list under the OSPF process to filter routes propagated to R3 using the pre-configured prefix list.

```
R2(config)# router ospf 1
R2(config-router)# distribute-list prefix EIGRP-FILTER out eigrp 1
```

```
R2(config-router)#
```

d. On R3, verify if the route is now missing from the R1 routing table.

```
R3# show ip route ospf | include O E2
O E2     172.16.1.0/24 [110/20] via 172.16.23.2, 00:13:55, Serial0/0/1
O E2     172.16.2.0/24 [110/20] via 172.16.23.2, 00:13:55, Serial0/0/1
O E2     172.16.12.0/24 [110/20] via 172.16.23.2, 00:13:55, Serial0/0/1
R3#
```

The output confirms that only the 172.16.0.0/16 networks are being advertised to R3.

Step 5: Filter redistributed routes using a route map.

The preceding two steps were simple examples of using a distribute list with an ACL and a prefix list. Both methods basically achieved the same result of filtering routes.

However, in large enterprise networks, route filtering can be quite complex. The ACLs can be very extensive and therefore taxing on router resources. For this reason, prefix lists should be used instead of ACLs since they are more efficient and less taxing on router resources than ACLs.

Route maps can also be used to filter redistributed routes. A route map works like an access list because it has multiple deny and permit statements that are read in a sequential order. However, route maps can match and set specific attributes and therefore provide additional options and more flexibility when redistributing routes.

Route maps are not just for redistribution. They are also commonly used for:

- **Policy-based routing (PBR)**— PBR allows an administrator to define routing policy other than basic destination-based routing using the routing table. The route map is applied to an interface using the **ip policy route-map** interface configuration command.
- **BGP**—Route maps are the primary tools for implementing BGP policy and allows an administrator to do path control and provide sophisticated manipulation of BGP path attributes. The route map is applied using the BGP **neighbor** router configuration command.

In this step, we will filter the R3 loopback 25 and 30 networks from being redistributed into EIGRP on R2.

a. Display the R1 routing table and verify that those two routes currently appear there.

```
R1# show ip route eigrp | begin Gateway
Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
D        172.16.2.0/24 [90/40640000] via 172.16.12.2, 01:39:20, Serial0/0/0
D EX     172.16.3.0/24 [170/40537600] via 172.16.12.2, 01:30:13,
Serial0/0/0
D        172.16.23.0/24 [90/41024000] via 172.16.12.2, 01:39:20,
Serial0/0/0
D        172.16.100.0/24 [90/40640000] via 172.16.12.2, 01:39:20,
Serial0/0/0
D EX  192.168.20.0/24 [170/40537600] via 172.16.12.2, 01:30:13, Serial0/0/0
D EX  192.168.25.0/24 [170/40537600] via 172.16.12.2, 01:30:13, Serial0/0/0
D EX  192.168.30.0/24 [170/40537600] via 172.16.12.2, 01:30:13, Serial0/0/0
D EX  192.168.35.0/24 [170/40537600] via 172.16.12.2, 01:30:13, Serial0/0/0
D EX  192.168.40.0/24 [170/40537600] via 172.16.12.2, 01:30:13, Serial0/0/0
D     192.168.48.0/23 is a summary, 01:39:20, Null0
R1#
```

b. There are multiple ways to configure this filtering. In this step, we will configure an ACL that matches these two network. Configure the following named access list to identify the two routes to be filtered.

```
R2(config)# ip access-list standard R3-ACL
R2(config-std-nacl)# remark ACL used with the R3-FILTER route map
R2(config-std-nacl)# permit 192.168.25.0 0.0.0.255
R2(config-std-nacl)# permit 192.168.30.0 0.0.0.255
R2(config-std-nacl)# exit
R2(config)#
```

```
R2(config)#ip access-list standard R3-ACL
R2(config-std-nacl)#remark ACL used with the R3-FILTER route map
R2(config-std-nacl)#permit 192.168.25.0 0.0.0.255
R2(config-std-nacl)#permit 192.168.30.0 0.0.0.255
R2(config-std-nacl)#exit
R2(config)#
```

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c. Configure a route map with a statement that denies based on a match with the named ACL. Then add a **permit** statement without a **match** statement. This acts as an explicit "*permit all*".

```
R2(config)# route-map R3-FILTER deny 10
R2(config-route-map)# description RM filters R3 OSPF routes
R2(config-route-map)# match ip address R3-ACL
R2(config-route-map)# exit
R2(config)# route-map R3-FILTER permit 20
R2(config-route-map)# description RM permits all other R3 OSPF routes
R2(config-route-map)# exit
R2(config)#
```

d. Apply this route map to EIGRP by reentering the **redistribute** command using the **route-map** keyword.

```
R2(config)# router eigrp 1
R2(config-router)# redistribute ospf 1 route-map R3-FILTER metric 64 100
255 1 1500
R2(config-router)#
```

e. Verify that the two R3 networks are filtered out in the R1 routing table.

```
R1# show ip route eigrp | begin Gateway
Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
D        172.16.2.0/24 [90/40640000] via 172.16.12.2, 00:02:20, Serial0/0/0
D EX     172.16.3.0/24 [170/40537600] via 172.16.12.2, 00:02:04,
Serial0/0/0
D        172.16.23.0/24 [90/41024000] via 172.16.12.2, 00:02:20,
Serial0/0/0
D        172.16.100.0/24 [90/40640000] via 172.16.12.2, 00:02:20,
Serial0/0/0
D EX  192.168.20.0/24 [170/40537600] via 172.16.12.2, 00:02:04, Serial0/0/0
D EX  192.168.35.0/24 [170/40537600] via 172.16.12.2, 00:02:04, Serial0/0/0
D EX  192.168.40.0/24 [170/40537600] via 172.16.12.2, 00:02:04, Serial0/0/0
D     192.168.48.0/23 is a summary, 00:02:31, Null0
R1#
```

Notice that the192.168.25.0/24 and 192.168.30.0/24 networks are no longer in the routing table.

Step 6: Filter redistributed routes and set attributes using a route map.

The preceding step was a simple example of using a route map to filter redistributed routes.
In this step, we will filter a route from R1 to change its metric and metric type.

a. On R3, verify the routing table entry for the routes learned externally identified with the 0 E2 source entry.

```
R3# show ip route ospf | include O E2
O E2     172.16.1.0/24 [110/20] via 172.16.23.2, 00:13:55, Serial0/0/1
O E2     172.16.2.0/24 [110/20] via 172.16.23.2, 00:13:55, Serial0/0/1
O E2     172.16.12.0/24 [110/20] via 172.16.23.2, 00:13:55, Serial0/0/1
R3#
```

The 172.16.12.0 route will be configured with additional attributes.

b. Configure a prefix list identifying the route to be filtered.

```
R2(config)# ip prefix-list R1-PL permit 172.16.12.0/24
R2(config)#
```

c. Configure a route map matching the identified route in the prefix list and assign the metric cost of 25 and change the metric type to External Type 1. Then add a **permit** statement without a **match** statement acting as an explicit "*permit all*".

```
R2(config)# route-map R1-FILTER permit 10
R2(config-route-map)# description RM filters 172.16.12.0/24
```

```
R2(config-route-map)# match ip address prefix-list R1-PL
R2(config-route-map)# set metric 25
R2(config-route-map)# set metric-type type-1
R2(config-route-map)# exit
R2(config)# route-map R1-FILTER permit 20
R2(config-route-map)# description RM permits all other R1 OSPF routes
R2(config-route-map)# exit
R2(config)#
```

d. Apply this route map to OSPF by reentering the **redistribute** command using the **route-map** keyword.

```
R2(config)# router ospf 1
R2(config-router)# redistribute eigrp 1 subnets route-map R1-FILTER
R2(config-router)# exit
R2(config)#
```

e. Verify that the two R3 networks are filtered out in the R1 routing table.

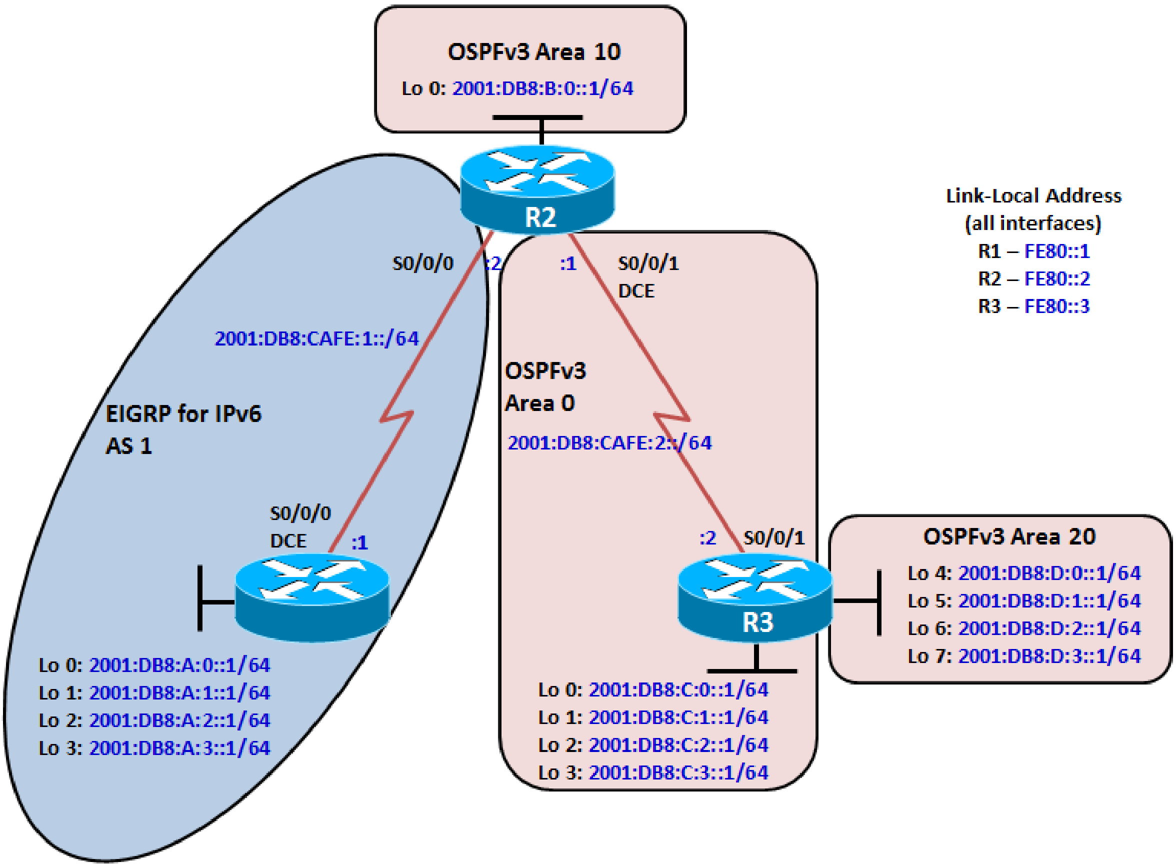
```
R3# show ip route ospf | begin Gateway
Gateway of last resort is not set

      172.16.0.0/16 is variably subnetted, 8 subnets, 2 masks
O E2     172.16.1.0/24 [110/20] via 172.16.23.2, 00:02:57, Serial0/0/1
O E2     172.16.2.0/24 [110/20] via 172.16.23.2, 00:02:57, Serial0/0/1
O E1     172.16.12.0/24 [110/1587] via 172.16.23.2, 00:02:57, Serial0/0/1
O IA     172.16.100.0/24 [110/1563] via 172.16.23.2, 00:02:57, Serial0/0/1
O     192.168.8.0/22 is a summary, 00:02:57, Null0
R3#
```

Notice that the172.16.12.0/24 route is now a type 1 route and calculates the actual metric.

Lab 4-3, Redistribution Between EIGRP for IPv6 And OSPFv3

Topology



Objectives

- Review EIGRP and OSPF configuration.
- Summarize routes in EIGRP.
- Summarize in OSPF at an ABR and an ASBR.
- Redistribute into EIGRP.
- Redistribute into OSPF.

Background

Two online booksellers, Example.com and Example.net, have merged and now need a short-term solution to inter-domain routing. Since these companies provide client services to Internet users, it is essential to have minimal downtime during the transition.

Example.com is running EIGRP while Example.net is running a multi-area OSPF. Because it is imperative that the two booksellers continuously deliver Internet services, you should bridge these two routing domains without interfering with each router's path through its own routing domain to the Internet.

The CIO determines that it is preferable to keep the two protocol domains shown in the diagram during the transition period, because the network engineers on each side need to understand the other's network before deploying a long-term solution. Redistribution will be a short-term solution.

In this scenario, R1 and R2 are running EIGRP while R2 is the OSPF autonomous system border router (ASBR) consisting of areas 0, 10, and 20. You need to configure R2 to enable these two routing protocols to interact to allow full connectivity between all networks.

In this lab, R1 is running EIGRP and R3 is running multi-area OSPF. Your task is to configure redistribution on R2 to enable these two routing protocols to interact, allowing full connectivity between all networks. In Appendix A of this lab, you explore the black hole operation.

Note: This lab uses Cisco 1941 routers with Cisco IOS Release 15.2 with IP Base. Depending on the router or switch model and Cisco IOS Software version, the commands available and output produced might vary from what is shown in this lab.

Required Resources

- 3 routers (Cisco IOS Release 15.2 or comparable)
- Serial and Ethernet cables

Step 1: Configure loopbacks and assign addresses.

a. Configure all loopback interfaces on the three routers in the diagram. Configure the serial interfaces with the IP addresses, bring them up, and set a DCE clock rate where appropriate.

```
R1(config-line)# interface Loopback0
R1(config-if)# ipv6 address 2001:db8:A:0::1/64
R1(config-if)# exit
R1(config)# interface Loopback1
R1(config-if)# ipv6 address 2001:db8:A:1::1/64
R1(config-if)# exit
R1(config)# interface Loopback2
R1(config-if)# ipv6 address 2001:db8:A:2::1/64
R1(config-if)# exit
R1(config)# interface Loopback3
R1(config-if)# ipv6 address 2001:db8:A:3::1/64
R1(config-if)# exit
R1(config)# interface serial 0/0/0
R1(config-if)# ipv6 address 2001:db8:cafe:1::1/64
R1(config-if)# ipv6 address fe80::1 link-local
R1(config-if)# clock rate 64000
R1(config-if)# no shutdown
R1(config-if)# exit
R1(config)#
*Oct 27 10:01:40.307: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Loopback0, changed state to up
*Oct 27 10:01:40.711: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Loopback1, changed state to up
*Oct 27 10:01:41.123: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Loopback2, changed state to up
R1(config)#
*Oct 27 10:01:41.435: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Loopback3, changed state to up
R1(config)#
*Oct 27 10:01:43.439: %LINK-3-UPDOWN: Interface Serial0/0/0, changed state
to down
R1(config)#
R1(config)#
*Oct 27 10:02:05.419: %LINK-3-UPDOWN: Interface Serial0/0/0, changed state
to up
*Oct 27 10:02:06.419: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0/0, changed state to up
R1(config)# exit
R1#

R2(config)# interface Loopback0
R2(config-if)# ipv6 address 2001:db8:B:0::1/64
R2(config-if)# exit
R2(config)#
R2(config)# interface serial 0/0/0
R2(config-if)# ipv6 address 2001:db8:cafe:1::2/64
R2(config-if)# ipv6 address fe80::2 link-local
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)#
R2(config)# interface serial 0/0/1
```

```
R2(config-if)# ipv6 address 2001:db8:cafe:2::1/64
R2(config-if)# ipv6 address fe80::2 link-local
R2(config-if)# clock rate 64000
R2(config-if)# no shutdown
R2(config-if)# exit
R2(config)#


R3(config)# interface Loopback0
R3(config-if)# ipv6 address 2001:db8:C:0::1/64
R3(config-if)# exit
R3(config)# interface Loopback1
R3(config-if)# ipv6 address 2001:db8:C:1::1/64
R3(config-if)# exit
R3(config)# interface Loopback2
R3(config-if)# ipv6 address 2001:db8:C:2::1/64
R3(config-if)# exit
R3(config)# interface Loopback3
R3(config-if)# ipv6 address 2001:db8:C:3::1/64
R3(config-if)# exit
R3(config)# interface Loopback4
R3(config-if)# ipv6 address 2001:db8:D:0::1/64
R3(config-if)# ipv6 address fe80::3 link-local
R3(config-if)# exit
R3(config)# interface Loopback5
R3(config-if)# ipv6 address 2001:db8:D:1::1/64
R3(config-if)# ipv6 address fe80::3 link-local
R3(config-if)# exit
R3(config)# interface Loopback6
R3(config-if)# ipv6 address 2001:db8:D:2::1/64
R3(config-if)# ipv6 address fe80::3 link-local
R3(config-if)# exit
R3(config)# interface Loopback7
R3(config-if)# ipv6 address 2001:db8:D:3::1/64
R3(config-if)# ipv6 address fe80::3 link-local
R3(config-if)#
R3(config)# interface serial 0/0/1
R3(config-if)# ipv6 address 2001:db8:cafe:2::2/64
R3(config-if)# ipv6 address fe80::3 link-local
R3(config-if)# clock rate 64000
R3(config-if)# no shutdown
R3(config-if)# exit
R3(config)#
```

```
R2(config-if)#ipv6 address 2001:db8:B:0::1/64
R2(config-if)#exit
R2(config)#interface serial 0/0/0
R2(config-if)#ipv6 address 2001:db8:cafe:1::2/64
R2(config-if)#ipv6 address fe80::2 link-local
R2(config-if)#no shutdown

R2(config-if)#
%LINK-5-CHANGED: Interface Serial0/0/0, changed state to up

R2(config-if)#exit
R2(config)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up

R2(config)#interface serial 0/0/1
R2(config-if)#ipv6 address 2001:db8:cafe:2::1/64
R2(config-if)#ipv6 address fe80::2 link-local
R2(config-if)#clock rate 64000
R2(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0/1, changed state to down
R2(config-if)#exit
R2(config)#
```

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b. Issue the **show ipv6 interface brief** command on each router and filter to include only the interface in an "up" status. Router R1 is shown as an example.

```
R1# show ipv6 interface brief | include up
Serial0/0/0            [up/up]
Loopback0              [up/up]
Loopback1              [up/up]
Loopback2              [up/up]
Loopback3              [up/up]
R1#
```

```
R1#show ipv6 interface brief
GigabitEthernet0/0         [administratively down/down]
GigabitEthernet0/1         [administratively down/down]
Serial0/0/0                [up/up]
    FE80::1
    2001:DB8:CAFE:1::1
Serial0/0/1                [administratively down/down]
Loopback0                  [up/up]
    FE80::2E0:F7FF:FEC8:1B84
    2001:DB8:A::1
Loopback1                  [up/up]
    FE80::202:16FF:FE90:C9B9
    2001:DB8:A:1::1
Loopback2                  [up/up]
    FE80::2D0:58FF:FEE3:BD73
    2001:DB8:A:2::1
Loopback3                  [up/up]
    FE80::290:2BFF:FE05:6C0E
    2001:DB8:A:3::1
Vlan1                      [administratively down/down]
R1#
```

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c. Verify that you can ping across the serial links when you are finished. Use the following Tcl script to check full and partial connectivity throughout this lab.

```
R1# tclsh

foreach address {
2001:db8:cafe:1::1
2001:db8:cafe:1::2
2001:db8:A:0::1
2001:db8:A:1::1
2001:db8:A:2::1
```

```
2001:db8:A:3::1
2001:db8:B:0::1
2001:db8:cafe:2::1
2001:db8:cafe:2::2
2001:db8:B:0::1
2001:db8:C:0::1
2001:db8:C:1::1
2001:db8:C:2::1
2001:db8:C:3::1
2001:db8:D:0::1
2001:db8:D:1::1
2001:db8:D:2::1
2001:db8:D:3::1
} { ping $address }
```

Which pings are successful and why?

RTA: En este punto, sólo las interfaces directamente conectadas tendrán éxito. Por ejemplo, R1 debería ejecutar con éxito las seis primeras direcciones IPv6 de la lista y fallar para todas las demás direcciones IPv6, ya que no están en redes conectadas directamente.

Step 2: Configure EIGRP for IPv6.

a. Enable IPv6 unicast routing and EIGRP for IPv6 on each router. Since there are no active IPv4 addresses configured, EIGRP for IPv6 requires the configuration of a 32-bit router ID. Use the **router-id** command to configure the router ID in the router configuration mode.

Note: Prior to IOS 15.2 the EIGRP IPv6 routing process is shut down by default and the no shutdown router configuration mode command is required to enable the routing process. Although not required with the IOS used in creating this lab, an example of the **no shutdown** command is shown for router R1.

Issue the **ipv6 eigrp 1** command on the interfaces that participate in the EIGRP routing process. EIGRP for IPv6 does not use the **network** command. IPv6 prefixes are enabled on the interface. Similar to EIGRP for IPv4, the AS number must match the neighbor's configuration for the router to form an adjacency.

```
R1(config)# ipv6 unicast-routing
R1(config)# ipv6 router eigrp 1
R1(config-rtr)# eigrp router-id 1.1.1.1
R1(config-rtr)# no shutdown
R1(config-rtr)# exit
R1(config)# interface range lo 0 - 3
R1(config-if-range)# ipv6 eigrp 1
R1(config-if-range)# exit
R1(config)# interface s0/0/0
R1(config-if)# ipv6 eigrp 1
R1(config-if)#


R2(config)# ipv6 unicast-routing
R2(config)# ipv6 router eigrp 1
R2(config-rtr)# eigrp router-id 2.2.2.2
R2(config-rtr)# no shutdown
R2(config-rtr)# exit
R2(config)#
```

```
R2(config)# interface lo 0
R2(config-if)# ipv6 eigrp 1
R2(config-if)# exit
R2(config)#
R2(config)# interface s0/0/0
R2(config-if)# ipv6 eigrp 1
R2(config-if)# exit
R2(config)#
*Aug 26 09:45:14.347: %DUAL-5-NBRCHANGE: EIGRP-IPv6 1: Neighbor
FE80::1 (Serial0/0/0) is up: new adjacency
R2(config)#
```

```
R1(config)#ipv6 unicast-routing
R1(config)#ipv6 router eigrp 1
R1(config-rtr)#eigrp router-id 1.1.1.1
R1(config-rtr)#no shutdown
R1(config-rtr)#exit
R1(config)#interface range lo 0 - 3
R1(config-if-range)#ipv6 eigrp 1
R1(config-if-range)#exit
R1(config)#interface s0/0/0
R1(config-if)#ipv6 eigrp 1
R1(config-if)#exit
R1(config)#
```

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b. Verify the EIGRP configuration using the **show ipv6 eigrp neighbors** and **show ipv6 route eigrp** commands on R2.

```
R2# show ipv6 eigrp neighbors
EIGRP-IPv6 Neighbors for AS(1)
H   Address                 Interface       Hold Uptime    SRTT   RTO
Q  Seq
                                            (sec)          (ms)
Cnt Num
0   Link-local address:     Se0/0/0           12 00:32:18 1297   5000
0  3
    FE80::1
R2#
R2# show ipv6 route eigrp

<Output omitted>

D   2001:DB8:A::/64 [90/2297856]
     via FE80::1, Serial0/0/0
D   2001:DB8:A:1::/64 [90/2297856]
     via FE80::1, Serial0/0/0
D   2001:DB8:A:2::/64 [90/2297856]
     via FE80::1, Serial0/0/0
D   2001:DB8:A:3::/64 [90/2297856]
     via FE80::1, Serial0/0/0
R2#
```

```
R2#show ipv6 eigrp neighbors
IPv6-EIGRP neighbors for process 1
H   Address                  Interface      Hold   Uptime    SRTT    RTO   Q   Seq
                                            (sec)            (ms)          Cnt Num
0   Link-local address:      Se0/0/0        11     00:00:48  40      1000  0   3
    FE80::1

R2#show ipv6 route eigrp
Translating "eigrp"...domain server (255.255.255.255)
% Invalid input detected
R2#
```

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c. Verify that R2 can reach all of the networks in the EIGRP for IPv6 routing domain using the following Tcl script.

```
R1# tclsh

foreach address {
2001:db8:cafe:1::1
2001:db8:cafe:1::2
2001:db8:A:0::1
2001:db8:A:1::1
2001:db8:A:2::1
2001:db8:A:3::1
} { ping $address }
```

All pings should be successful. Troubleshoot if necessary.

Step 3: Manually summarize with EIGRP for IPv6.

To make routing updates more efficient and ultimately reduce the size of routing tables, contiguous EIGRP routes can be summarized out an interface by using the **ipv6 summary-address eigrp** *as network mask* interface configuration command.

a. On R1, summarize the loopback interface networks.

```
R1(config)# interface s0/0/0
R1(config-if)# ipv6 summary-address eigrp 1 2001:db8:A::/62
R1(config-if)#
*Oct 27 11:05:33.019: %DUAL-5-NBRCHANGE: EIGRP-IPv6 1: Neighbor
FE80::2 (Serial0/0/0) is resync: summary configured
R1(config-if)#
```

```
R1(config)#interface s0/0/0
R1(config-if)#ipv6 summary-address eigrp 1 2001:db8:A::/62
R1(config-if)#
%DUAL-5-NBRCHANGE: IPv6-EIGRP 1: Neighbor FE80::2 (Serial0/0/0) is up: new
adjacency
```

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b. Verify the routing table of R2 using the **show ipv6 route eigrp** command.

```
R2# show ipv6 route eigrp

<Output omitted>

D   2001:DB8:A::/62 [90/2297856]
     via FE80::1, Serial0/0/0
R2#
```

c. Verify that R2 can still reach all of the networks in the EIGRP for IPv6 routing domain using the following Tcl script.

```
R1# tclsh

foreach address {
2001:db8:cafe:1::1
2001:db8:cafe:1::2
2001:db8:A:0::1
2001:db8:A:1::1
2001:db8:A:2::1
2001:db8:A:3::1
} { ping $address }
```

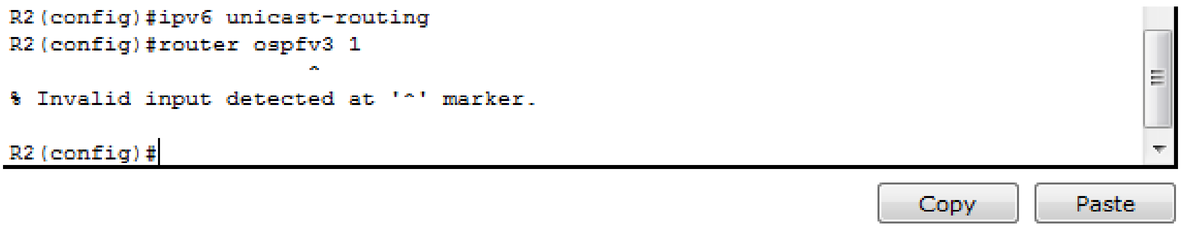
All pings should be successful. Troubleshoot if necessary.

Step 4: Configure OSPFv3 Address Family.

OSPFv3 with the addresses family (AF) unifies OSPF configuration for both IPv4 and IPv6. OSPFv3 with address families also combines neighbor tables and the LSDB under a single OSPF process. OSPFv3 messages are sent over IPv6 and therefore requires that IPv6 routing is enabled and that the interface has a link-local IPv6 address. This is the requirement even if only the IPv4 AF is configured.

a. On R2, configure OSPFv3 address family, router ID, and enable the OSPFv3 on the interface using the **ospfv3 1 ipv6 area** command.

```
R2(config)# ipv6 unicast-routing
R2(config)#
R2(config)# router ospfv3 1
R2(config-router)# address-family ipv6 unicast
*Aug 26 10:40:35.203: %OSPFv3-4-NORTRID: Process OSPFv3-1-IPv6 could
not pick a router-id, please configure manually
R2(config-router-af)# router-id 2.2.2.2
R2(config-router-af)# exit-address-family
R2(config-router)# exit
R2(config)#
R2(config)# interface Loopback0
R2(config-if)# ospfv3 1 ipv6 area 10
R2(config-if)# exit
R2(config)#
R2(config)# interface serial 0/0/1
R2(config-if)# ospfv3 1 ipv6 area 0
R2(config-if)# exit
R2(config)#
```



b. On R3, configure OSPFv3 address family, router ID, and enable the OSPFv3 on the interface using the **ospfv3 1 ipv6 area** command.

```
R3(config)# router ospfv3 1
R3(config-router)# address-family ipv6 unicast
R3(config-router-af)#
```

```
*Jul 28 03:10:48.395: %OSPFv3-4-NORTRID: Process OSPFv3-1-IPv6 could
not pick a router-id, please configure manually
R3(config-router-af)# router-id 3.3.3.3
R3(config-router-af)# exit-address-family
R3(config-router)# exit
R3(config)#
R3(config)# interface range lo 0 - 3
R3(config-if-range)# ospfv3 1 ipv6 area 0
R3(config-if-range)# exit
R3(config)#
R3(config)# interface range lo 4 - 7
R3(config-if-range)# ospfv3 1 ipv6 area 20
R3(config-if-range)# exit
R3(config)#
R3(config-if)# interface serial 0/0/1
R3(config-if)# ospfv3 1 ipv6 area 0
R3(config-if)# exit
R3(config)#
*Jul 28 03:20:29.267: %OSPFv3-5-ADJCHG: Process 1, IPv6, Nbr 2.2.2.2
on Serial0/0/1 from LOADING to FULL, Loading Done
R3(config)#
R3(config)#
```

c. Verify that your adjacencies come up with the **show ipv6 ospf neighbor** command, and make sure that you have routes from OSPF populating the R2 routing table using the **show ipv6 route ospf** command.

```
R2# show ipv6 ospf neighbor

            OSPFv3 Router with ID (2.2.2.2) (Process ID 1)

Neighbor ID     Pri   State           Dead Time   Interface ID
Interface
3.3.3.3           0   FULL/  -        00:00:31    6
Serial0/0/1
R2#
R2# show ipv6 route ospf

<Output omitted>

O   2001:DB8:C::1/128 [110/64]
     via FE80::3, Serial0/0/1
O   2001:DB8:C:1::1/128 [110/64]
     via FE80::3, Serial0/0/1
O   2001:DB8:C:2::1/128 [110/64]
     via FE80::3, Serial0/0/1
O   2001:DB8:C:3::1/128 [110/64]
     via FE80::3, Serial0/0/1
OI  2001:DB8:D::1/128 [110/64]
     via FE80::3, Serial0/0/1
```

```
OI  2001:DB8:D:1::1/128 [110/64]
     via FE80::3, Serial0/0/1
OI  2001:DB8:D:2::1/128 [110/64]
     via FE80::3, Serial0/0/1
OI  2001:DB8:D:3::1/128 [110/64]
     via FE80::3, Serial0/0/1
R2#
```

d. Verify the OSPF IPv6 routing table of R3.

```
R3# sho ipv6 route ospf

<Output omitted>

OI  2001:DB8:B::1/128 [110/64]
     via FE80::2, Serial0/0/1
R3#
```

e. Verify that R2 and R3 can reach all of the networks in the OSPFv3 routing domain using the following Tcl script.

```
R3# tclsh

foreach address {
2001:db8:B:0::1
2001:db8:cafe:2::1
2001:db8:cafe:2::2
2001:db8:B:0::1
2001:db8:C:0::1
2001:db8:C:1::1
2001:db8:C:2::1
2001:db8:C:3::1
2001:db8:D:0::1
2001:db8:D:1::1
2001:db8:D:2::1
2001:db8:D:3::1
} { ping $address }
```

All pings should be successful. Troubleshoot if necessary.

Step 5: Configure mutual redistribution between OSPFv3 and EIGRP for IPv6.

Notice that R2 is the only router with knowledge of all routes (EIGRP for IPv6 and OSPFv3) in the topology at this point, because it is involved with both routing protocols. Next you will redistribute the EIGRP for IPv6 routes into OSPFv3 and the OSPFv3 routes into EIGRP for IPv6.

a. To redistribute the EIGRP for IPv6 routes into OSPFv3, on R2 issue the **redistribute eigrp 1 include-connected** command.

```
R2(config)# router ospfv3 1
R2(config-router)# address-family ipv6 unicast
R2(config-router-af)# redistribute eigrp 1 include-connected
R2(config-router-af)# exit
R2(config-router)# exit
```

A default seed metric is not required for OSPFv3. Redistributed routes are assigned a metric of 20 by default.

b. To redistribute the OSPFv3 routes into EIGRP for IPv6, on R2 issue the **redistribute ospf 1 metric 10000 100 255 1 1500** command. Unlike OSPFv3, EIGRP for IPv6 must specify the metric associated to the redistributed routes. The command tells EIGRP to redistribute OSPF process 1 with these metrics: bandwidth of 10000, delay of 100, reliability of 255/255, load of 1/255, and a MTU of 1500.

```
R2(config)# ipv6 router eigrp 1
R2(config-rtr)# redistribute ospf 1 metric 1500 100 255 1 1500
include-connected
R2(config-rtr)# exit
R2(config)#
```

c. Issue the **show ipv6 protocols** command on the redistributing router, R2. Compare your output with the following output.

```
R2# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "application"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "eigrp 1"
EIGRP-IPv6 Protocol for AS(1)
  Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  NSF-aware route hold timer is 240
  Router-ID: 2.2.2.2
  Topology : 0 (base)
    Active Timer: 3 min
    Distance: internal 90 external 170
    Maximum path: 16
    Maximum hopcount 100
    Maximum metric variance 1

  Interfaces:
    Loopback0
    Serial0/0/0
  Redistribution:
    Redistributing protocol ospf 1 with metric 1500 100 255 1 1500
(internal, external 1 & 2, nssa-external 1 & 2) include-connected
IPv6 Routing Protocol is "ospf 1"
  Router ID 2.2.2.2
  Area border and autonomous system boundary router
  Number of areas: 2 normal, 0 stub, 0 nssa
  Interfaces (Area 0):
    Serial0/0/1
  Interfaces (Area 10):
    Loopback0
  Redistribution:
    Redistributing protocol eigrp 1 include-connected
R2#
```

d. Display the routing table on R1 to verify the redistributed routes. Redistributed OSPFv3 routes display on R1 as EX, which means that they are external EIGRP for IPv6 routes.

```
R1# show ipv6 route eigrp
```

```
<Output omitted>

D   2001:DB8:A::/61 [5/128256]
     via Null0, directly connected
D   2001:DB8:B::/64 [90/2297856]
     via FE80::2, Serial0/0/0
EX  2001:DB8:C::1/128 [170/2244096]
     via FE80::2, Serial0/0/0
EX  2001:DB8:C:1::1/128 [170/2244096]
     via FE80::2, Serial0/0/0
EX  2001:DB8:C:2::1/128 [170/2244096]
     via FE80::2, Serial0/0/0
EX  2001:DB8:C:3::1/128 [170/2244096]
     via FE80::2, Serial0/0/0
EX  2001:DB8:D::1/128 [170/2244096]
     via FE80::2, Serial0/0/0
EX  2001:DB8:D:1::1/128 [170/2244096]
     via FE80::2, Serial0/0/0
EX  2001:DB8:D:2::1/128 [170/2244096]
     via FE80::2, Serial0/0/0
EX  2001:DB8:D:3::1/128 [170/2244096]
     via FE80::2, Serial0/0/0
EX  2001:DB8:CAFE:2::/64 [170/2244096]
     via FE80::2, Serial0/0/0
R1#
```

e. Display the routing table on R3 to see the redistributed routes. Redistributed EIGRP routes are tagged in the R3 routing table as O E2, which means that they are OSPF external type 2. Type 2 is the default OSPF external type.

```
R3# show ipv6 route ospf

<Output omitted>

OE2 2001:DB8:A::/61 [110/20]
     via FE80::2, Serial0/0/1
OI  2001:DB8:B::1/128 [110/64]
     via FE80::2, Serial0/0/1
OE2 2001:DB8:CAFE:1::/64 [110/20]
     via FE80::2, Serial0/0/1
R3#
```

f. Verify full connectivity with the following Tcl script:

```
R1# tclsh

foreach address {
2001:db8:cafe:1::1
2001:db8:cafe:1::2
2001:db8:A:0::1
2001:db8:A:1::1
2001:db8:A:2::1
2001:db8:A:3::1
2001:db8:B:0::1
```

```
2001:db8:cafe:2::1
2001:db8:cafe:2::2
2001:db8:B:0::1
2001:db8:C:0::1
2001:db8:C:1::1
2001:db8:C:2::1
2001:db8:C:3::1
2001:db8:D:0::1
2001:db8:D:1::1
2001:db8:D:2::1
2001:db8:D:3::1
} { ping $address }
```

All pings should now be successful. Troubleshoot as necessary.

CONCLUSION

Su implementación en redes para el envió de paquetes así como su configuración entre otras cualidades y prestaciones como las observadas por los protocolos de enrutamiento dinámico", reconociendo entre otros características, la diferencia entre el enrutamiento por vector de distancia y de estado de enlace así como la manera en que los router utilizan dichos protocolos para determinar la ruta más corta hacia cada red y la forma en que los routers que ejecutan un protocolo de enrutamiento de estado de enlace envían información acerca del estado de sus enlaces a otros routers en el dominio de enrutamiento

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